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COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
MAY 71 J CALVIN, F H CLOSNER, R J COFFMAN

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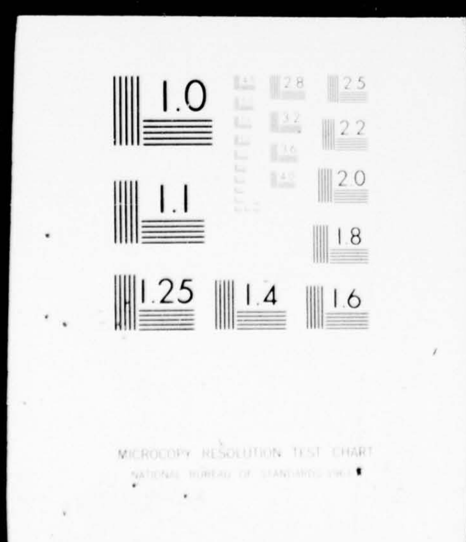

Columbia-North Pacific Region

Comprehensive Framework Study
of Water and Related Lands

APPENDIX VIII
VOLUME 2

LAND MEASURES & WATERSHED PROTECTION

SUBMITTED BY

PACIFIC NORTHWEST RIVER BASINS COMMISSION
1 COLUMBIA RIVER, VANCOUVER, WASHINGTON

MAY 1971

This appendix is one of a series making up the complete Columbia-North Pacific Region Framework Study on water and related lands. The results of the study are contained in the several documents as shown below:

Main Report	Brochure Report

Appendices

I.	History of Study	IX.	Irrigation
II.	The Region	X.	Navigation
III.	Legal & Administrative Background	XI.	Municipal & Industrial Water Supply
IV.	Land & Mineral Resources	XII.	Water Quality & Pollution Control
V.	Water Resources	XIII.	Recreation
VI.	Economic Base & Projections	XIV.	Fish & Wildlife
VII.	Flood Control	XV.	Electric Power
VIII.	Land Measures & Watershed Protection	XVI.	Comprehensive Framework Plans

Pacific Northwest River Basins Commission
1 Columbia River
Vancouver, Washington

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APPENDIX VIII

Columbia-North Pacific Region
Comprehensive Framework Study

Volume 2
[Subregions 6-12]

of Water and Related Lands. Appendix VIII. Land Measures and Watershed Protection. Volume 2. Subregions 6-12,

10 11 May 1971 12 389p.

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Prepared by
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APPENDIX VIII
LAND MEASURES AND WATERSHED PROTECTION

Prepared under the direction of the
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This appendix to the Columbia-North Pacific Region Framework Report was prepared at field level under the auspices of the Pacific Northwest River Basins Commission. It is subject to review by the interested Federal agencies at the departmental level, by the Governors of the affected States, and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

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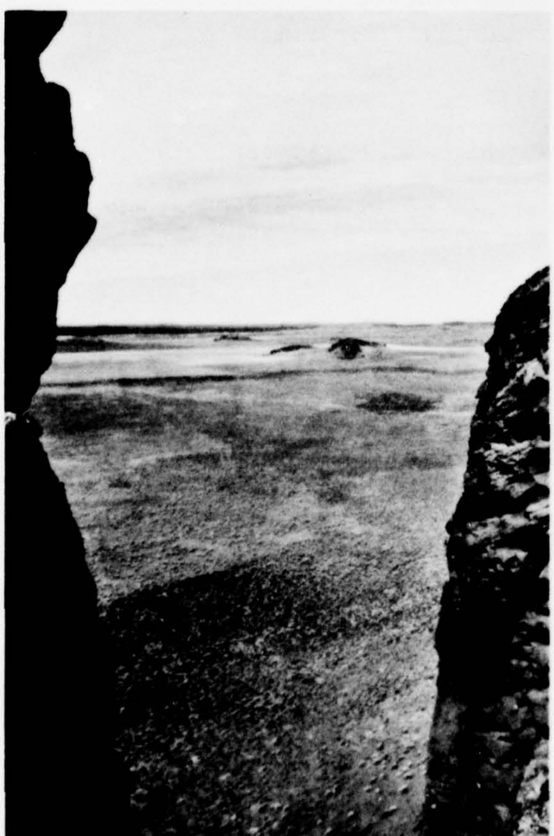


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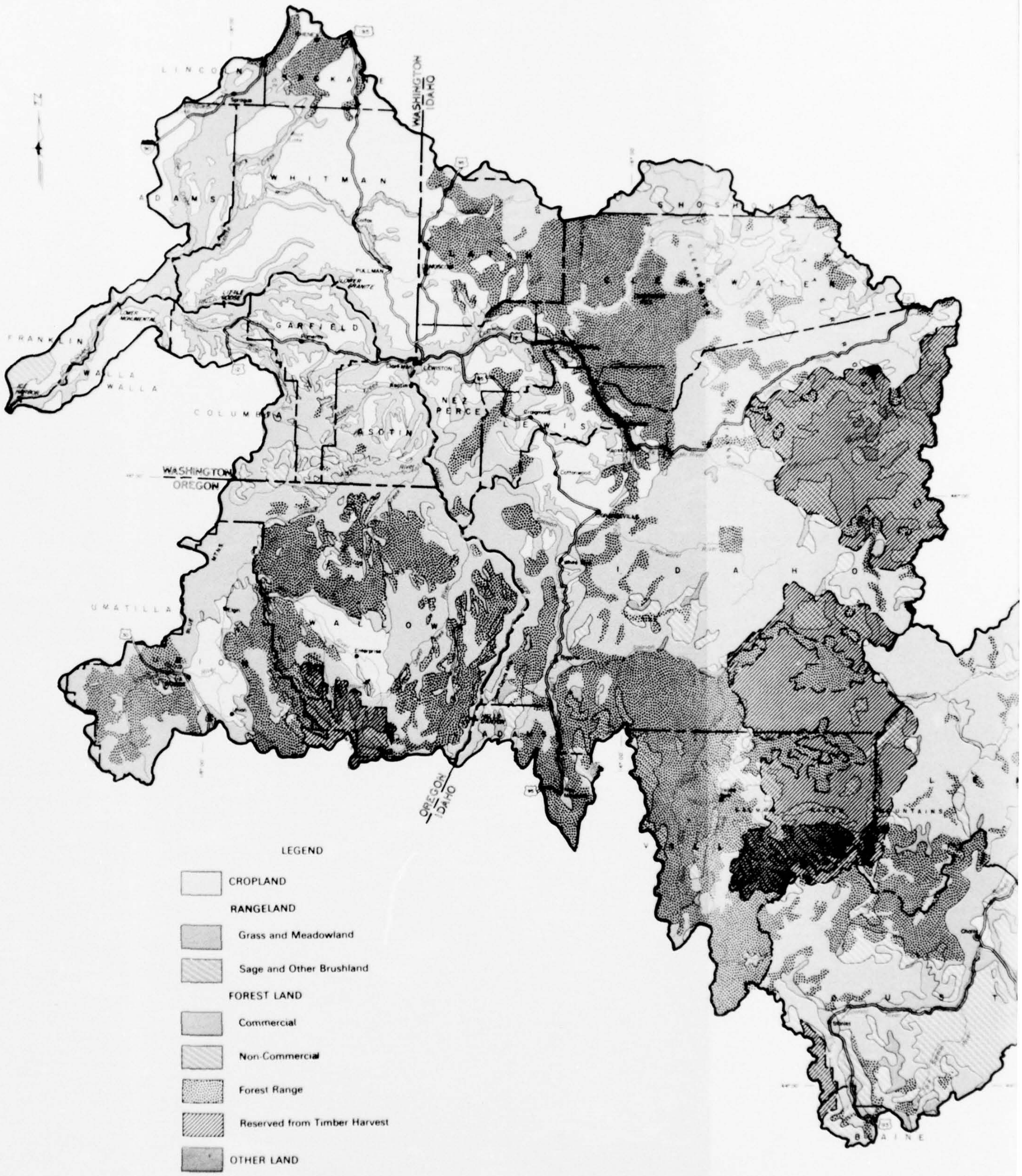
LOCATION MAP

SUBREGION 6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CLEARWATER
WASHINGTON
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WALLOWA
UNION
IDAHO
OREGON
IDAHO
BLAINE
LEGEND
CROPLAND
RANGELAND
Grass and Meadowland
Sage and Other Brushland
FOREST LAND
Commercial
Non-Commercial
Forest Range
Reserved from Timber Harvest
OTHER LAND

LOCATION MAP

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED COVER AND LAND USE

LOWER SNAKE, SUBREGION 6

1968

FIGURE 37

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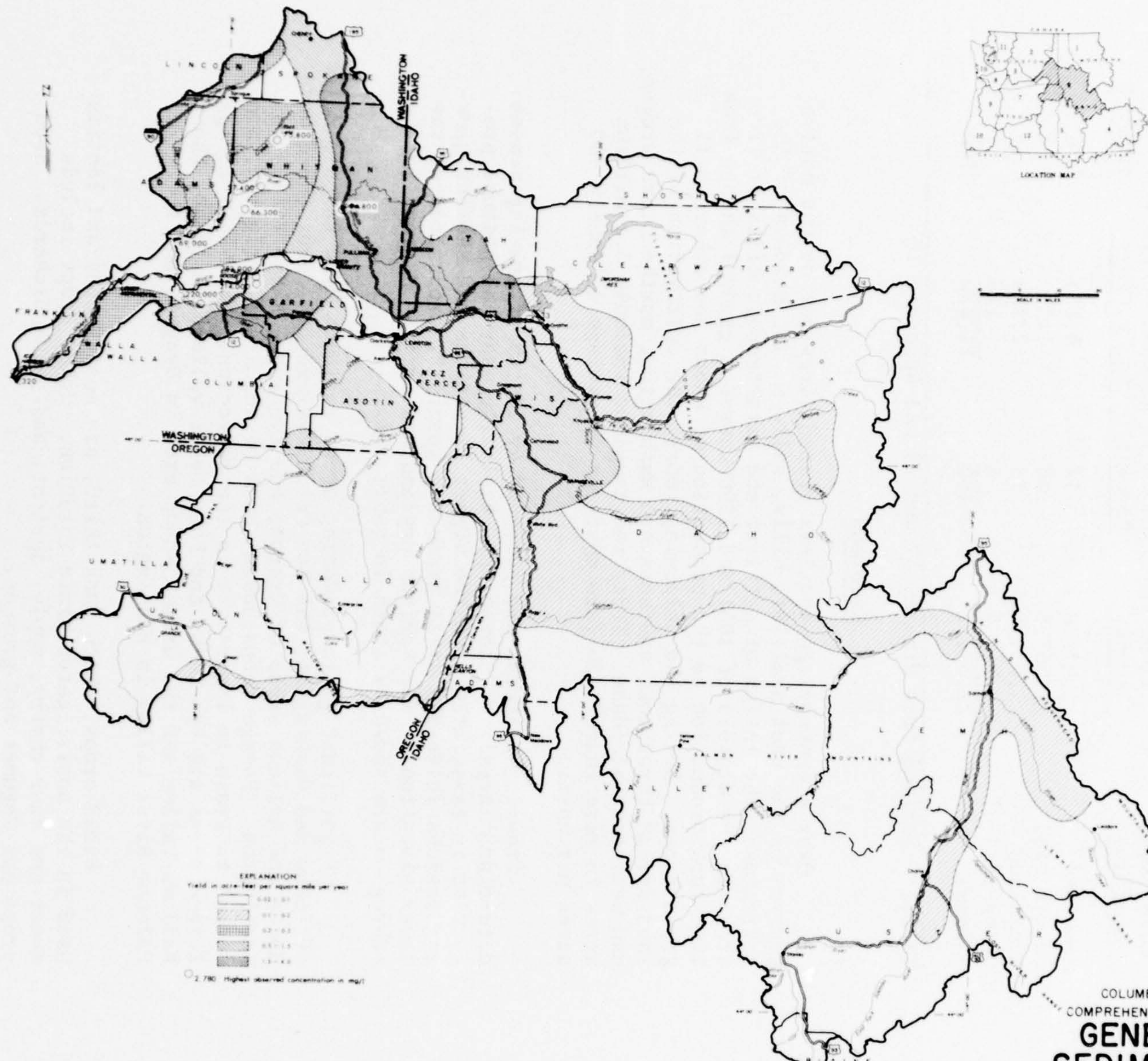


COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

LOWER SNAKE SUBREGION 6

1968

FIGURE 38

Table 260 - Generalized Sediment Yield by Cover and Land Use, Subregion 6

Cover and Land Use	1,000 Acres	Percent	Sediment Yield Ac.Ft./Year	Percent
Cropland	3,077.8	14	8,130	70
Forest Land	13,537.1	60	1,226	11
Rangeland	5,041.8	23	2,154	18
Other Land	714.5	3	120	1
Total	22,371.2	100	11,630	100

Source: Derived from figures 37 and 38 and Appendix IV.

Cropland

Over a century ago settlers grazed livestock on the native grasses of the vast prairies, hills, valleys, and meadows of the subregion. The influx of settlers and catastrophic kills of livestock in the winters of 1881 and 1890 caused a gradual change from livestock production to the production of wheat and other small grain crops. During the following years, the cultivation of the land spread throughout southeastern Washington, northeastern Oregon, and west-central Idaho. Today the cropland includes 3.1 million acres in more than 7,700 farm units or an average of nearly 400 acres per unit.

Cropping patterns are governed by length of growing season determined largely by elevation. Basically, hay and pasture production is associated with the higher elevations and shorter growing seasons while the small grain and specialty crops grow at the lower elevations. The various dryland and irrigated crops in the subregion are shown by state in table 261.

Significant grain producing areas include: the Palouse Hills of Idaho and Washington; the Nez Perce Prairie of Idaho; the Grande Ronde and Wallowa areas of Oregon; and the Snake River Valley in Washington. Forage crops, about half of which are irrigated, are second to grain in importance in the subregion. The major irrigated forage areas are the Lemhi and Pahsimeroi valleys in Idaho, the Wallowa Valley and the Grande Ronde area in Oregon, and the Palouse River Valley in Washington.

Field crops, which rank third, are mostly peas and lentils used in the nonirrigated grain rotation. Other crops include sweet and sour cherry, apple, apricot, and peach orchards. Seed crops are legumes and grasses.

Irrigated areas are located primarily along permanent streams. In Washington, the irrigated area is on the Snake River

terraces and scattered along the bottomlands of a number of creeks and rivers, such as the Palouse and Tucannon. The irrigated areas in Idaho are interspersed with the dry lands along the Clearwater River, on the Snake River terraces, and on the bottomlands along the Salmon, Lemhi, and Pahsimeroi rivers. The major irrigated areas in Oregon are on bottomlands and terraces in the Grande Ronde and the Wallowa River valleys.

Table 261 - Types of Crops, Subregion 6, 1966

	Idaho	Oregon	Washington	Total
		(1,000 Acres)		
Dryland Crops				
Hay & Pasture	135.0	41.6	16.1	192.7
Field Crops	215.7	6.7	111.3	333.7
Grain	442.9	139.5	1,006.8	1,589.2
Fallow	67.5	5.0	524.7	597.2
Seed Crops1/	4.4	6.0	6.6	17.0
Other2/	67.6	.2	12.4	80.2
Total Dryland Crops	933.1	199.0	1,677.9	2,810.0
Irrigated Crops				
Hay & Pasture	128.5	54.3	21.3	204.1
Grain	7.8	31.4	3.9	43.1
Row Crops	2.6	-	2.7	5.3
Field Crops	-	6.2	2.2	8.4
Seed Crops1/	-	5.9	-	5.9
Other2/	.3	.1	.6	1.0
Total Irrigated Crops	139.2	97.9	30.7	267.8
Total Cropland	1,072.3	296.9	1,708.6	3,077.8

1/ Includes legumes and grasses.
2/ Includes sweet and sour cherries, apples, apricots, peaches.
Source: Appendix IV, Land and Mineral Resources

Water Conservation

The subregion has an abundant supply of water with irrigation being a major consumer. Water management problems stem from the seasonal distribution of annual precipitation, since runoff occurs mostly in the spring months. Conversely, low streamflows coincide with peak irrigation demand during the summer months. Improper management of irrigation water allows it to be lost through floods, ditch seepage, poor distribution of water on the farm, and reduced water quality.

Efficiency of water application usually follows irrigation system improvement. Much of the present inefficiency in water application can be attributed directly to the inadequate design and construction of farm irrigation systems. Table 262 shows the work accomplished on irrigated lands to provide more efficient irrigation.

The type of distribution systems for irrigation water varies in size from large irrigation developments to single farm diversions from a creek or river. Scme of the more recently reorganized systems are community pipelines, often with gravity pressure adequate for the operation of sprinklers.

Table 262 - Water Conservation Practices Applied on Cropland through 1966, Subregion 6

Practice	Unit	Idaho	Oregon	Wash.	Subregion
Water Control Facilities	No.	1,305	893	2,139	4,337
Irrigation Water Conveyance Facilities	Miles	288	244	217	749
Water Storage Facilities	No.	1,379	1,062	663	3,104
Irrigation Systems Surface	No.	2,968	1,694	68	4,730
Irrigation Systems Sprinkler	No.	529	247	774	1,550
Land Shaping	1000 Acs.	15.8	8.5	18.5	42.8
Irrigation Water Management	1000 Acs.	13.5	5.1	30.2	48.8

Source: USDA Soil Conservation Service Data

The most pressing problem in the irrigated area is the late-season water supply because this area receives only a small amount of summer rain. Supplemental water is necessary for most intensively managed crops. With the exception of the main stems of the Salmon, Clearwater, and Snake rivers, all other streams in the irrigated cropland areas are inadequate for present needs. Of the 221,000 acres irrigated from streamflow, 123,000 acres are short of water between July 1 and September 1. Availability of water and method of irrigation by source are presented in table 263.

On the nonirrigated cropland, land measures installed primarily for erosion control also provide water conservation. Deep rooted legumes in the rotation increase permeability by providing channels for water into the subsoil and substrata. The grain stubble left on the surface during the stubble mulching operations enhances the infiltration of water by lessening puddling of the

Table 263 - Water Availability and Irrigation Methods for Cropland, Subregion 6, 1966

Item	Idaho	Oregon	Wash.	Total	Percent
	----------1000 Acres------------				
Water Source					
Streamflow	131.6	73.9	15.5	221.0	82
Groundwater	1.0	3.5	5.8	10.3	4
Reservoir Storage	6.5	20.5	9.5	36.5	14
Total Cropland Irrigated	139.1	97.9	30.8	267.8	100
Areas with adequate supplies	78.8	45.0	20.9	144.7	54
Areas with inadequate supplies	60.3	52.9	9.9	123.1	46
					100
Method of Application					
Sprinkler	7.7	23.8	27.7	59.2	22
Flooding	131.4	74.1	3.1	208.6	78
					100

Source: USDA, Soil Conservation Service River Basin Data

soil, by absorbing the pounding action of raindrops, by slowing the velocity of the water runoff, and by reducing the amount of erosion by the wind. Contour stripcropping, consisting of alternate strips of grain and fallow shortens the flow of water on unprotected soil and allows better infiltration and retention of the water on the vegetated strips. Subsoiling and chiseling, which breaks up layers of compacted soil, such as plowpans, allows a greater quantity of water to enter the soil. Diversion terraces decelerate the runoff by conducting the water across the slope to a protected waterway and by increasing the amount of infiltration.

Water is stored in impoundments and in the soil profile. All water storage facilities are valuable for water conservation regardless of their primary purpose. By storing water during the season of major runoff and releasing it during the season of low precipitation, the stored water can supply all uses, including irrigation, during times of low streamflow; it can improve the water quality by maintaining more uniform flow throughout the year; and it can help the recharge of the ground-water supply.

Drainage

Approximately 151,000 acres of cropland have a wetness problem associated with irrigation from improper irrigation water management, canal seepage, or inadequate outlets, or from runoff and seepage from mountain footslopes (table 264).

Table 264 - Cropland Areas with a Wetness Problem
Subregion 6, 1966

Capability Class	Idaho	Oregon	Washington	Total
		(1,000 Acres)		
II	-	-	1	1
III	-	84	5	89
IV	56	-	5	61
Total	56	84	11	151

Source: Soil Conservation Service, C-NPRBS Data

The major wet problem areas in the Palouse Hills are caused by position in the landscape and restricted soil permeability. Tile drainage and outlets are the practice most commonly needed. In Idaho, problem areas are the Pahsimeroi, Lemhi, Salmon, and Clearwater valleys. On the Nez Perce Prairie, concave slopes and slow permeability of the soils impound the water and demand an artificial drainage installation. In Oregon, drainage problems in the Grande Ronde and Wallowa valleys are caused by seepage, runoff, surplus water from irrigation. Improved drainage practices as well as more efficient irrigation water management practices are necessary to correct the poorly drained areas.

Almost 1,200 miles of drainage facilities have been installed. Drainage has allowed farmers to make cropping adjustments, to increase the length of the growing season, and to make farming operations easier. Drainage practices that have been established in cropland are shown in table 265.

Table 265 - Drainage Practices Applied to Cropland
Subregion 6, 1966

	Unit	Idaho	Oregon	Wash.	Total
Drainage Conduits and Ditches	Miles	202	244	743	1,189
Drainage Structures	No.	9	2	62	73

Source: USDA, Soil Conservation Data

Erosion and Sedimentation

Almost 2.7 million acres or 86 percent of the cropland have an erosion potential (table 266). However, adequate land treatment measures and proper land use have reduced erosion on about 1.4 million acres. The practices are listed in table 267. These land treatment measures must be repeated on the 1.4 million acres to safeguard against future erosion. Erosion continues to be an increasing problem on 1.3 million acres or 42 percent of the cropland that has not been adequately treated or properly used. Winter rains on frozen soil, snowmelt, summer storms, wind action, inadequate cultural methods, and inefficient irrigation water management are the principal causes of erosion.

Table 266 - Cropland Areas with an Erosion Potential by Capability Class, Subregion 6, 1966

Capability Class	Idaho	Oregon	Washington	Total
II	6	64	238	308
III	821	56	926	1,803
IV	51	138	361	550
Total	878	258	1,525	2,661

Source: Soil Conservation Service C-NPRBS Data

Adequate ground cover, diversion terraces or other treatment methods could have prevented this serious erosion problem to cropland. (SCS W-3709-16)

The yield of sediment from the total cropland area reflects only a small part of the erosion and sedimentation occurrence within each field. Most of the accelerated erosion and sedimentation occurs over a few hundred lineal feet on slopes and at the break in slopes within each field. Approximately 8,100 acre-feet of sediment are eroded from cropland areas annually (table 260). Although cropland is only 14 percent of the total land, this quantity of sediment accounts for 70 percent of the total sediment load in the annual runoff.

The Palouse Hills and the footslopes of the Blue Mountains which are well known for the high yields of grain produced by deep, fertile, loess soils are also well known for the prevailing critical erosion problems. The Nez Perce Prairie in Idaho and the Grande Ronde and Wallowa valleys are noted for the moderate to severe erosion. In some places all of the topsoil has been lost and the crop yields have been reduced to less than half of the normal yield.

Table 267 - Erosion Control Practices Applied on Cropland
Subregion 6, 1966

	Unit	Idaho	Oregon	Wash.	Total
Conservation Cropping System	1000 Acs.	333.4	71.8	714.4	1,119.6
Crop Residue Use	1000 Acs.	313.7	65.3	964.0	1,343.0
Ditch Bank Seeding	Miles	1.1	2.6	27.2	30.9
Diversions and Terraces	Miles	4.8	35.4	308.8	349.0
Field Windbreak	Miles	0.8	11.5	28.6	40.9
Grade Stabilization Structures	No.	12	--	68	80
Grassed Waterway or Outlet	Acres	1.9	0.4	4.8	7.1
Pasture and Hayland Planting	1000 Acs.	45.4	12.0	56.2	113.6
Stripcropping	1000 Acs.	26.0	3.8	39.1	68.9
Stubblemulching	1000 Acs.	0.7	3.0	229.4	233.1

Source: USDA, Soil Conservation Data

Flooding

Over 122,000 acres of cropland are subject to flooding. Floods, generally occurring during the winter or early spring, result from unseasonal rain and snowmelt. Floods caused by the melting of the snowpack result in extended periods of high flows with large volumes. The most serious floods occur when rainstorms of wide extent and above normal temperatures cause rapid melting of the snow over frozen soil.

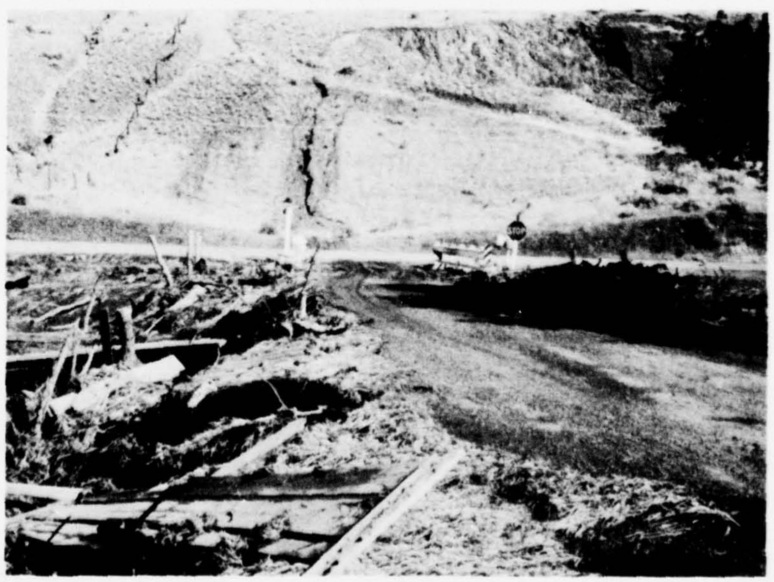
During the summer months, floods from rains are caused by infrequent convective storms, commonly called cloudbursts. Although these storms are small in area covered, they may cause very high peak flows and may be accompanied by hail. Crops are especially vulnerable during this season of the year. Flood damages to all land, crops, structures, and natural streams have been estimated in Appendix VII, Flood Control, on an average annual basis as over $5.3 million.

A number of practices have proven effective in reducing flood damage. Table 268 shows the present status of work on flood control that has been accomplished on private land by individuals and small groups.

Table 268 - Flood Prevention Measures Applied on Cropland Areas, Subregion 6, 1966

Item	Unit	Idaho	Oregon	Washington	Total
Stream Channel Improvements	Miles	21.6	37.8	170.0	229.4
Dikes & Levees	Miles	4.9	14.6	1.6	21.1

Source: USDA, Soil Conservation Service Data



Floodwater damages are quite evident as shown by debris and sediment deposited along roadways. Upstream property damage is evident from type of material deposited along the roadside. (SCS W-3709-9)

Forest Land

Forests cover 13.5 million acres or 60 percent of the total land area in the subregion. About 86 percent is in public and 14 percent is in private ownership. Of this total, 76 percent is commercial forest land and 24 percent is noncommercial.

This commercial forest land currently supports nearly 74.6 billion board feet of merchantable timber, 81 percent on public land, 19 percent on private. It furnishes the raw material for industry that accounts for 81 percent of all manufacturing employment. The 1964 timber harvest exceeded one billion board feet. The noncommercial forest land, 3.4 million acres, provides summer range for wildlife and livestock, including key big game winter ranges, as well as essential summer forage.

Approximately 82 percent of the subregion's total water yield originates on this forest area. On the average, this amounts to about 18.8 million acre-feet or almost 1.4 acre-feet per acre of forest land. Nearly 84 percent of the subregion's urban population depends on these watersheds for domestic water. Irrigation withdrawals, amounting to almost 800,000 acre-feet annually, are produced essentially on these same areas.

The forest lands of the subregion are generally in a good condition with minor erosion problems overall. Average sediment production is slightly over 1,200 acre-feet per year, which represents 11 percent of the total sediment coming from all the lands in the subregion (table 269).

About 82 percent of the forest land is in the very low category with sediment the result of natural or geologic erosion. The remaining 18 percent is distributed among the more critical areas where land use activities have accelerated erosion. It is

Table 269 - Present Sediment Yield Forest Land, Subregion 6

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield: Acre-feet Per Square Mile	Annual Sediment Yield: Total Acre-feet	Percent
Very low	11,025.9	82	0.02 - 0.1	345	28
Low	2,040.2	15	0.1 - 0.2	319	26
Medium	16.6	--	0.2 - 0.5	5	--
High	325.1	2	0.5 - 1.5	254	21
Very high	129.3	1	1.5 - 4.0	303	25
Total	13,537.1	100		1,226	100

Source: Derived from figures 37 and 38.

on these areas, particularly the 3 percent in the high and very high categories, that watershed protection work is presently concentrated. Most protection practices are applied on current operating areas to prevent a reduction in present water quality.

Watershed Protection

The general timber harvest method used is to log individual or groups of trees. Logs are yarded by tractors on gentle terrain or by mobile cable yarders where topography is steeper. On most lands, tractor trails and temporary roads are cross-drained and seeded to grass and legumes to reduce surface erosion and distribute runoff. On logging areas, debris is removed from live streams and major draws, preventing washouts which usually occur during high water.

Most roads have permanent drainage structures and some heavily used roads are surfaced. Many exposed cutbank and fill slopes are fertilized and seeded to grass, preventing sediment wash. Road maintenance during and after log hauling protects the road and drainage structures as well as the soil and water resources.

Reforestation measures include both planting and seeding. Site preparation, such as burning or scarification, precedes these activities, as well as on areas where natural reseeding is anticipated. Advance reproduction in the partial cut areas is protected during logging operations. A summary of the harvest activities and protection requirements is outlined in table 270.

Table 270 - Average Annual Timber Harvest Activity, Subregion 6

	Unit	Public	Private	Total
Harvest Area	Ac.	85,000	25,000	110,000
Area Reforested 1/	Ac.	50,000	15,000	65,000
Slash Disposal Area	Ac.	45,000	5,000	50,000
Disturbed Area Treated 2/	Ac.	4,500	--	4,500
Harvest Road Required	Mi.	430	125	555
Harvest Road Treated 3/	Mi.	365	10	375

1/ Includes seeding, planting and site preparation. Balance either adequately stocked or requires no regeneration work.
2/ Includes seeding, mulching, debris removal and cross-draining skidroads and logging areas.
3/ Cut and fill stabilization only.

Watershed Rehabilitation

About 20 percent of the forest land has erosion problems that produce 70 percent of the sediment yield from forest lands (table 269). Most of this results from water movement through road ditches, down abandoned roads, and across areas logged over or overgrazed years ago. Past watershed protection measures were either inadequate or lacking altogether. These areas, particularly in public ownership, are now being rehabilitated as rapidly as funds permit. Such work on the public forest areas includes land treatment on only about 255 acres annually. Nearly 265 miles of existing and abandoned roads and 56 miles of stream are also treated each year (table 271).

Table 271 - Average Annual Accomplishment, Watershed Rehabilitation Practices on Public Forest Land, Subregion 6

Practice	Unit	National Forest 1/	Public Domain	Indian Lands	State Lands
Sheet Erosion Control	Acres	125	100	-	-
Gully Stabilization	Miles	53	-	-	-
Stream Clearance & Stabilization	Miles	55	-	1	-
Existing Road & Trail Rehabilitation 2/	Miles	252	5	3	-
Reservoir Protection	Acres	-	-	-	-

1/ Average of period 1964-66.
2/ Includes abandoned roads.
Source: Data furnished by agency as listed.

Not included in this average accomplished (table 271) are areas rehabilitated following forest fires. Broadcast seeding of grasses will sufficiently stabilize the soil in many areas. In others, grass seeding along with such measures as stream channel clearance, culvert and trash rack installation, are required. The following photo shows the 1968 results of helicopter seeding on the 7,100 acre Cotter Bar Fire of August 1967.

Burned Area REhabilitation, Nezperce National Forest, Cotter Bar Fire, Seeded in the fall of 1967. Photo taken Sept. 1968. (Forest Service)

Water Yield Improvement

There are no management problems for water yield improvement in the subregion at this time. Activities such as logging and thinning do increase water yields but this is not the primary objective. Water yield improvement programs on public lands are in the planning stage and are discussed in the Future Needs and Means to Satisfy Needs Section.

Rangeland

The 5.0 million acres of rangeland in this subregion represent 23 percent of the total land area (table 260). About 2.6 million acres are privately owned and account for 51 percent of all rangeland. The public range includes 2.1 million acres of Federal land and 287,000 acres of state land. Range type and ownership are discussed in Appendix IV, Land and Mineral Resources.

During early range livestock operations, natural forage was used at a rate far in excess of the production capacity of the range, resulting in decreased forage productivity and soil stability. Periodic wildfires caused further damage. Rangeland conditions have improved considerably since about 1930. Excessive grazing use had been reduced on an estimated 4.7 million acres through 1965 (92 percent of all rangeland). Yet, about 34 percent of the range acreage remained in poor condition by 1966, and range recovery will take many years in drier areas with steeper slopes and unstable, shallow soils. Present range condition and grazing capacity are shown on table 272. Grass and forbs comprise the predominant cover on 65 percent of the range, sagebrush on 30 percent, and other brush and shrubs on the remaining 5 percent. The average grazing capacity is about 6 acres per animal unit.

Table 272 - Rangeland Condition and Capacity, Subregion 6, 1966

Range Type and Condition	Ownership					
	Public		Private		Total	
	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)
Grassland						
Good	317.6	105.9	395.5	131.8	713.1	237.7
Fair	428.4	65.9	872.4	134.2	1,300.8	200.1
Poor	260.7	20.8	808.9	64.7	1,069.6	85.5
Seeded Range 1/	106.5	42.6	111.4	44.6	217.9	87.2
Total	1,113.2	235.2	2,188.2	375.3	3,301.4	610.5
Sagebrush						
Good	233.0	58.2	39.4	9.9	274.4	68.1
Fair	584.0	68.7	98.5	11.6	682.5	80.3
Poor	463.0	26.5	78.9	4.5	541.9	31.0
Total	1,280.0	153.4	216.8	26.0	1,496.8	179.4
Other Brush						
Good	14.1	4.0	35.1	10.0	49.2	14.0
Fair	29.4	3.7	73.2	9.3	102.6	13.0
Poor	26.2	.9	65.6	2.2	91.8	3.1
Total	69.7	8.6	173.9	21.5	243.6	30.1
Total						
Good 2/	671.2	210.7	581.4	196.3	1,254.6	407.0
Fair	1,041.8	138.3	1,044.1	155.1	2,085.9	293.4
Poor	749.9	48.2	953.4	71.4	1,703.3	119.6
Grand Total	2,462.9	397.2	2,578.9	422.8	5,041.8	820.0
Percent Distribution	48.8	48.4	51.2	51.6	100.0	100.0
Average AC/AUM	6.2		6.1		6.1	

1/ Seeded range acreage was combined with good condition grassland in Appendix IV.
2/ Includes seeded range.
Source: Rangeland narrative, C-NP Appendix IV, Subregion 6. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

Serious erosion problems exist in the Palouse Basin, the Blue Mountain foothills, and on the Nez Perce Prairie. In some southern portions of Columbia and Garfield counties in Washington, a part of the Blue Mountain foothills, highly productive bottomlands have gullies, entrenched as deep as 20 feet. In addition, wet meadow areas have been damaged when downcutting gullies lowered the water table. In areas of sparse vegetation such as stock trails and ridge tops in these counties, erosion is quite severe and all topsoil is gone. On sandy terraces and benches adjacent to the

Snake River in Washington, unstable soils are subject to severe wind and water erosion unless adequately protected by vegetation. High rates of sheet and rill erosion occur during the intense summer convection storms and during periods of snowfall or rain on frozen soil. The average annual rangeland sediment yield is 2,154 acre-feet (table 273), about 18 percent of the sediment produced from all lands in the subregion. Around 76 percent of the sediment from rangeland (1,630 acre-feet) comes from 18 percent of the range acreage in the "Very High," "High," and "Medium" yield categories, primarily in the areas described above.

Table 273 - Sediment Yield from Rangeland, Subregion 6, 1966

Sediment Yield Categories	Grassland	Sagebrush & Shrubs	Total	Percent
		Rangeland Acreage (1,000 Acres)		
Very Low	1,737.9	1,467.1	3,205.0	63
Low	677.7	273.3	951.0	19
Medium	260.5	--	260.5	5
High	438.4	--	438.4	9
Very High	186.9	--	186.9	4
Total	3,301.4	1,740.4	5,041.8	100
		Annual Sediment Yield (Acre-Feet)		
Very Low	163	138	301	14
Low	159	64	223	10
Medium	142	--	142	7
High	685	--	685	32
Very High	803	--	803	37
Total	1,952	202	2,154	100

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.
Source: Derived from figures 37 and 38.

Flooding is not a particularly serious problem on range areas, but rangeland use and management practices have a significant effect on flood and sediment problems of downstream or adjacent cropland and urban areas.

Channel cutting is shown here on rangeland near Challis in the Upper Salmon River area. Steep, bare slopes and highly erodible soils allow excessive runoff and downstream sediment damage. (Bureau of Land Management)

Measures and Practices for Watershed Protection

Rangeland practices accomplished through 1965 for watershed protection and improvement are shown on table 274. Most of these have multiple objectives and benefits and many of them serve

Table 274 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Up to 1966, Subregion 6 1/

Measures & Practices	Units	Land Ownership: Public 3/	Private	Total	Watershed Purposes 2/: (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	106,500	111,500	218,000	-	x	x	x
Brush Control	Acres	33,100	34,700	67,800	-	x	x	-
Weed Control	Acres	122,300	128,100	250,400	-	x	x	-
Fertilizing	Acres	1,200	1,200	2,400	-	-	x	-
Contouring, Pitting, Furrowing	Acres	1,400	1,500	2,900	-	x	x	-
Irrigation	Acres	160	160	320	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,300	1,400	2,700	-	x	x	-
Reducing Excessive Grazing Use	Acres	2,275,200	2,382,300	4,657,500	-	x	x	-
Livestock & Game Water Facilities	Number	1,400	1,400	2,800	-	x	x	-
Road Stabilization	Miles	68	NA 4/	NA 4/	-	x	x	-
Stream Clearance	Miles	3	3	6	-	-	x	-
Pollution Abatement	Miles	1	1	2	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	400	400	800	-	x	x	-
	Acre Ft.	400	400	800	-	x	x	-
Detentions	Number	5	5	10	-	x	x	x
	Cu. Yds.	48,700	50,900	99,600	-	x	x	x
Check Dams (Gully Plugs)	Number	5	5	10	-	x	x	x
	Cu. Yds.	4,200	4,400	8,600	-	x	x	x
Diversions	Number	2	2	4	-	-	x	-
	Cu. Yds.	600	600	1,200	-	-	x	-

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.
4/ Not available.

management objectives other than watershed improvement. Cover improvement and soil stabilization practices have been applied on about 542,000 acres of rangeland, mainly revegetation of an estimated 218,000 acres (primarily grass seeding), brush control on 68,000 acres, and weed control on 250,000 acres.

Significant progress has been made in adjusting livestock grazing use to the grazing capacity of the range and achieving better livestock distribution for improved watershed condition. About 2,800 livestock and game watering facilities have been developed and 2,700 miles of livestock fence constructed. These allowed a wider and more systematic livestock use and excessive grazing was reduced on an estimated 4.7 million acres. Of importance in this reduction has been the development of grazing management systems providing sufficient rest periods for natural revegetation of range cover. Watershed protection measures to reduce erosion and excessive runoff have been included in the maintenance and improvement of about 68 miles of public range roads and trails and a number of private access ways.

Water control structures have been developed to reduce erosion, control debris, and conserve early season runoff for subsequent livestock, recreation, and fish and wildlife use. These include about 800 ponds and small reservoirs with a combined storage capacity of some 800 acre-feet, and a small number of water detention structures, gully plugs, and diversion dams.

Other Land

Other land covers about 714,500 acres or 3 percent of the land area. The different categories of other land are shown in table 275.

Table 275 - Other Land Areas, Subregion 6, 1966

Kinds of Land	State of: Oregon	Washington	Idaho	Total	Extent
	-----1000 Acres-----				Percent
Barren	50.2	46.6	471.1	567.9	79
Roads and Railroads	10.3	41.1	17.7	69.1	10
Small Water	8.7	9.3	10.6	28.6	4
Urban, Industrial & Misc.	11.2	22.7	15.0	48.9	7
Total	80.4	119.7	514.4	714.5	100

Source: Appendix IV, Land and Mineral Resources.

Homes, business and industrial establishments have been severely damaged by floods in a number of towns in this subregion. Almost 1,800 acres of urban area are subject to flooding, and many times this amount have erosion and sedimentation problems caused by floods. In Washington, the Palouse River has damaged the cities of Pullman, Colfax, Palouse, and other smaller communities by flooding. Pomeroy, Pataha, and Asotin have been flooded by other streams. Annual damage of roads and railroads occurs throughout the Palouse area.

In Oregon, the cities of LaGrande, Elgin, and Union in the Grande Ronde area, as well as several other communities, have suffered flood damage. In the recent floods of December 1964 and January 1965, the city of LaGrande was flooded from adjacent drainage areas, as well as the Grande Ronde River. The municipal water supply of the city of Union is polluted by siltation from upstream watersheds when there is a major flood. The city of Wallowa has been damaged by floods from the overflow of an irrigation canal wasteway of inadequate capacity.

FUTURE NEEDS

Population is projected to increase from 156,000 in 1960 to 274,000 in 2020, an increase of 76 percent, with an accompanying demand for urban lands and recreational land use areas. Cropland is expected to decrease 43,000 acres and other land uses to increase 168,000 acres (table 276). The increase of other land will occur on present cropland and forest land. Forest land will decrease 457,000 acres and rangeland 6,000 acres.

Table 276 - Projected Change in Cover and Land Uses, Subregion 6

Item	1966	1980	2000	2020
		(1,000 Acres)		
Cropland	3,078.0	3,058.0	3,046,0	3,035.0
Forest Land	13,537.0	13,492.0	13,436.0	13,380.0
Rangeland	5,042.0	5,040.0	5,038.0	5,036.0
Other Land	714.0	763.0	823.0	882.0
Total	22,371.0	22,353.0	22,343.0	22,333.0

Source: Appendix VI, Economic Base and Projections.

Cropland

While the total population is expected to increase 76 percent by 2020, the farm population will decrease by 66 percent (from 26,600 to 11,700). This will require increased production by fewer farm workers.

Increased agricultural production will be on irrigated cropland areas. The acreage of irrigated land is projected to expand by approximately 475,000 acres (from 268,000 to 743,000 acres) as is shown in table 277.

Table 277 - Projected Trends in Dry and Irrigated Cropland, Subregion 6

Cropland	1966	1980	2000	2020
		(1,000 acres)		
Dry Farmed	2,810.0	2,626.0	2,515.0	2,292.0
Irrigated	267.8	432.0	531.0	743.0
Total1/	3,077.8	3,058.0	3,046.0	3,035.0

1/ Economic Research Service, C-NPRBS Projections
Source: Approximately 97 percent of the total area projections shown in Appendix IX, Irrigation

Changing land use, cultural practices, crops, and public demands will modify the status of agriculture in the subregion. Dry-farmed land is predicted to decrease more than 500,000 acres by 2020. A shift in land use and treatment will enable the more erodible areas to be converted to moisture and soil conserving crops and practices.

Water Conservation

Demand for food production by 2020 will require an expansion of irrigated cropland. Water resources for irrigation will be developed by increasing storage facilities, by using ground-water supplies, by improving distribution systems, and by changing application methods. The change in irrigation methods to meet the demand for improved water management and for greater efficiency is shown in table 278. Not only will crops now being produced be more productive with adequate irrigation, but new and more profitable crops can be introduced.

Table 278 - Projected Cumulative Trend in the Method of Irrigation on Cropland, Subregion 6

Item	1966	1980	2000	2020
		(1,000 Acres)		
Sprinkler Systems	59.2	132.6	402.5	648.4
Flood Systems	208.6	163.4	128.5	94.6
Total	267.8	296.0	531.0	743.0

Source: C-NPRBS Projections

Drainage

Production on approximately 151,000 acres of cropland is presently limited by wetness. Drainage practices have been applied on 44,000 acres. By 2020, with an increase in irrigated cropland, 156,000 acres will be subject to drainage problems. To obtain required cropland production, drainage practices must be applied on about 112,000 acres by 2020. The rate at which drainage work must be completed to meet the increased food and fiber needs is shown in table 279.

Table 279 - Cumulative Cropland Areas Needing Drainage Subregion 6

Item	1966	1980	2000	2020
		(1,000 Acres)		
Wet Areas	151.0	152.4	154.2	156.4
Projected Accomplishments	44.3	60.3	81.6	103.1
Remaining	106.7	92.1	72.6	53.3

Source: Soil Conservation Service, C-NPRBS Projections

Erosion and Sedimentation

Cropland areas with erosion potential are expected to increase about 267,000 acres or from less than 2.7 million acres to more than 2.9 million acres. At the present, 1.3 million acres have erosion problems of soil loss and sediment accumulation. A combination of vegetative and structural measures are needed to reduce these problems to an acceptable level. The increase in the erosion problem and the rate at which these areas need treatment are shown in table 280.

Table 280 - Cumulative Cropland Areas Needing Erosion Control, Subregion 6

Item	1966	1980	2000	2020
		(1,000 Acres)		
Erosion Potential	2,661.0	2,734.1	2,830.9	2,927.6
Projected Accomplishments	1,398.0	1,752.5	2,224.5	2,696.6
Remaining	1,263.0	981.6	606.4	231.0

Source: Soil Conservation Service, C-NPRBS Projections

Flooding

At the present time, over 122,000 acres of cropland are subject to flooding. The net area is not expected to change by any large amount by the year 2020. A number of reservoirs need to be constructed in this period, to protect the present flooded areas as well as to protect the land projected to be developed as cropland.

Forest Land

The forest industries of the subregion will require an estimated 311 million cubic feet of raw material per year by the year 2020. This volume will need to be produced on the 10 million acres of commercial forest land which is estimated to remain in timber production by the end of this period. This amounts to a need for 31 cubic feet per acre. The present industrial consumptive rate is 24 cubic feet per acre of commercial land, while present growth is about 20 cubic feet per acre per year. Timber yield improvements will be required if future growth rates are to meet future industrial demand. In this subregion, restocking, thinning, release and intermediate cuts are the principal management practices that need to be employed to increase projected yields.

Potential forest land sediment yield levels have been delineated on figure 39 and table 281. They represent potential yields prior to the establishment of protective measures and could exceed present yields by 4-1/2 times.

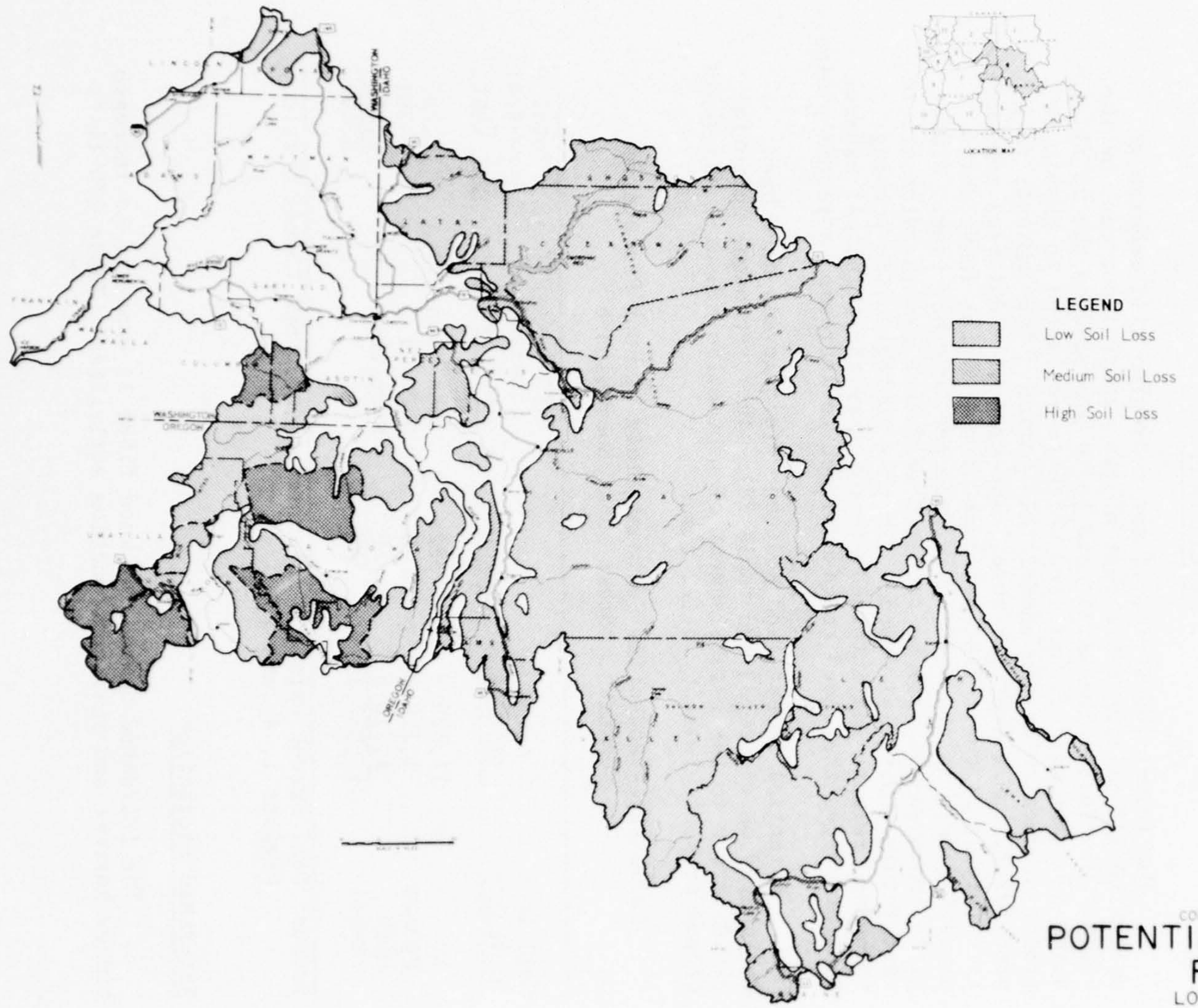
Table 281 - Potential Sediment Yield without Protective Measures, Forest Land, Subregion 6

Soil Loss Category	Acres (1,000)	Percent	Acre-feet per Square Mile per Year	Total Acre-feet per Year
Low	11,099.9	82	less than 0.2	2,255
Medium	1,218.6	9	0.2 - 1.5	381
High	1,218.6	9	more than 1.5	2,856
Total	13,537.1	100		5,492

Source: Soil Survey Data and Interpretations, USDA Forest Service, Regions 1, 4, and 6.

Watershed Protection

The increased demand for wood fiber is expected to increase timber harvest and road construction activities. Table 270 lists



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

POTENTIAL EROSION HAZARD FOREST LAND

LOWER SNAKE, SUBREGION 6

1968

FIGURE 39

the present status of these programs and table 282 shows the increase that will occur in meeting future demands for timber products. Projections are based on an increasing scale of wood fiber yield per acre.

Table 282 - Projected Cumulative Timber Harvest Activity
Forest Land, Subregion 6 1/

	Unit	1980	2000	2020
Timber Harvest Area	Ac.	1,648,000	3,844,000	6,040,000
Road Construction	Mi.	8,300	19,200	30,200
Ground Disturbance 2/	Ac.	165,000	384,000	604,000

1/ Based on the 1965 level of timber requirements.
2/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.

As indicated in table 282, soil cover will have been damaged on over 600,000 acres of forest land in the next 50 years. These areas, disturbed through logging operations and road construction, will require stabilization as cover loss occurs since the highest levels of sediment yield will originate here, unless adequate protective measures are provided.

With over 6 million acres coming under harvest by 2020, improved management practices on public lands and accelerated technical assistance for the private sector are needed to maintain both water quality and soil productivity.

Watershed Rehabilitation

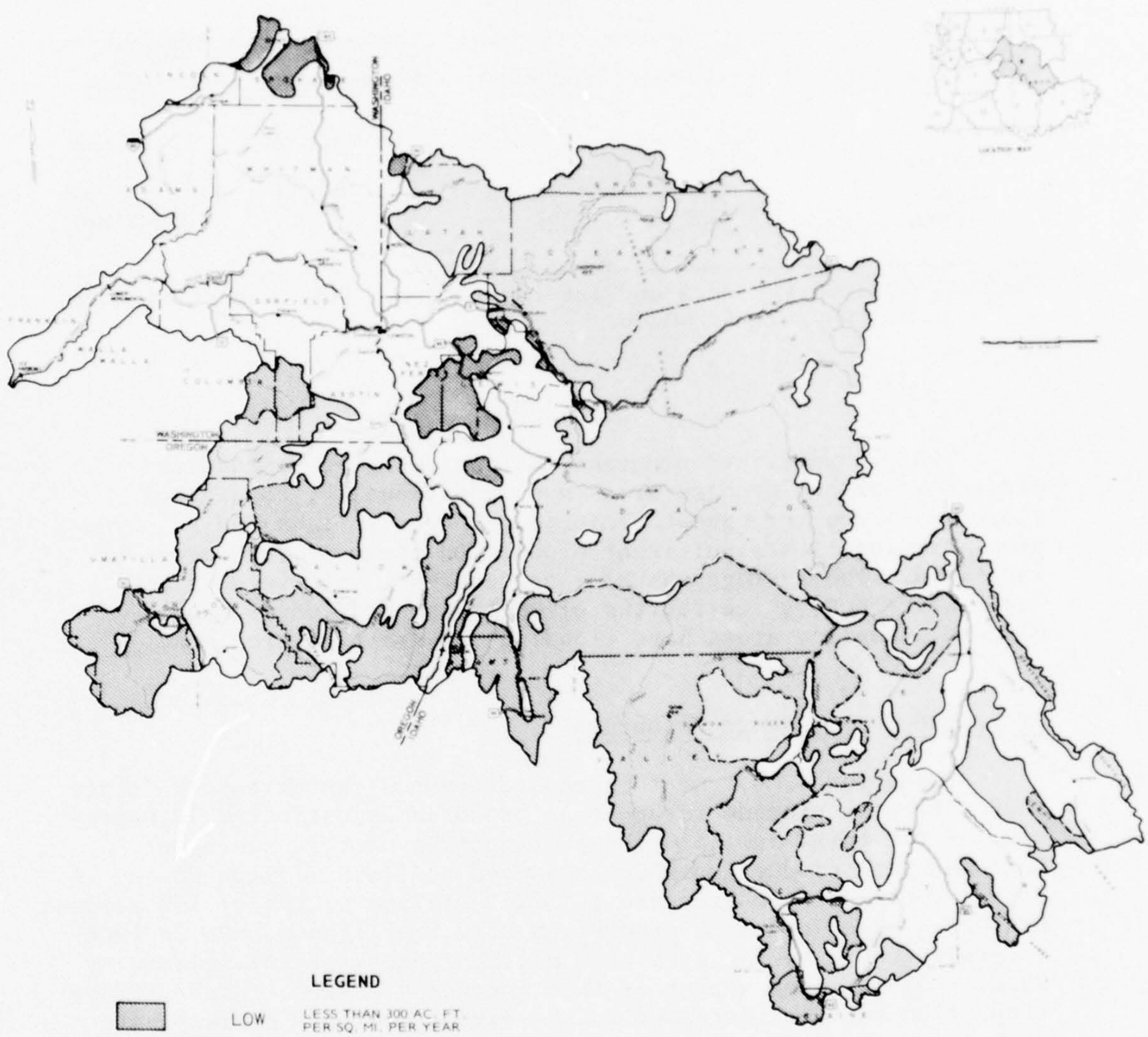
Watershed rehabilitation work is needed in critical erosion areas to restore water quality. On 20 percent or 2.5 million acres of forest land, critical erosion areas (table 269) still require watershed rehabilitation measures to improve water quality. This includes stabilization of old logging tracts, overgrazed areas, roads, unstable streams, and mining operations. An example of the erosion that can occur in areas where the soil cover and natural flow patterns of water have been disturbed is shown in the following photo.

Lack of cross-drainage or revegetation resulted in gullies on an abandoned tractor road. (Forest Service)

Water Yield Improvement

The subregion's forest lands are and will continue to be the dominant source of domestic, industrial, and agricultural water supplies. The 18.8 million acre-feet originating on forest lands is adequate for all foreseeable demands for water. However, seasonal highs and lows create problems in supply since the highest demand for water coincides with the lowest streamflow. Modification of streamflow characteristics through storage, cover manipulation, water spreading, and snowpack management is one solution.

The Water Retention Capacity Map (figure 40) and accompanying table 283 indicate the forest soils where permeability and water retention factors offer the best opportunity for application of water yield improvement practices. They indicate areas with high infiltration rates or large water storage capacities where vegetative cover manipulation and snowpack management would be most effective.



LEGEND

LOW	LESS THAN 300 AC. FT. PER SQ. MI. PER YEAR	
MEDIUM	300-1,500 AC. FT. PER SQ. MI. PER YEAR	
HIGH	MORE THAN 1,500 AC. FT. PER SQ. MI. PER YEAR	

COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER RETENTION CAPACITY
FOREST LAND

LOWER SNAKE, SUBREGION 6

1968

FIGURE 40

Table 283 - Water Retention Capacity, Forest Soils
Subregion 6

Retention Class	Acres (1,000)	Percent	Acre-feet per Square Mile	Total Acre-feet
Low	4,873.6	36	less than 300	1,500,000
Medium	8,122.1	60	300 - 1,500	11,400,000
High	541.4	4	more than 1,500	5,100,000
Total	13,537.1	100		18,000,000

Source: Soil Survey Data and Interpretations, USDA Forest Service, Regions, 1, 4, and 6.

Rangeland

Future watershed programs must be designed to resolve present watershed problem areas and, additionally, to protect range resources throughout projected changes in land and resource use. Erosion is a significant problem on about 886,000 acres of rangeland. The average annual rangeland sediment yield is about 2,154 acre-feet, three-fourths of which is produced from this acreage. Smaller areas have flooding and drainage problems.

Projected Use of Range Resources

Rangelands must meet increased demands for livestock forage. They currently provide forage that produces an estimated 12.9 percent of the total beef and sheep production of this subregion. Beef and veal production, which amounted to 118.5 million pounds in 1964, is expected to increase to 272.0 million pounds or 130 percent by 2020. Sheep and lamb production of 8.2 million pounds in 1964 is projected to increase to 18.9 million pounds or 131 percent by 2020. (3) To meet a part of this increased demand, future forage production must be increased to the extent possible commensurate with proper land management and resource utilization. Rangelands must also meet increased demands for wildlife habitat protection and more intensive recreation use.

Watershed Needs

About 380,000 acres of rangeland have received land treatment for erosion and sedimentation control with accompanying flood control and drainage benefits. This includes most of the measures and practices for cover improvement and soil stabilization given in the "Present Status" section, along with accomplishments in

road stabilization. Where multiple practices are involved, overlapping acreage was deleted. Present and anticipated future erosion problem areas will require an additional 271,000 acres of land treatment by 1980, 649,000 acres by 2000, and 1.1 million acres by 2020. Adequate erosion and sediment control also requires a number of small water control structures, such as diversion or detention dams and check dams (gully plugs).

Protection and management practices have been significant in improvement of watershed conditions on some 4.7 million acres. This includes reduction or adjustment of excessive livestock grazing use to the grazing capacity of the range, special fire control practices where required, development of stock and game water facilities and construction of livestock control fences. These practices must be intensified and extended to an additional 60,000 acres by 1980, 98,000 acres by 2000, and 135,999 acres by 2020.

An estimated 8 miles of streams and waterways in rangeland areas have been improved by stream clearance, channel improvement, or efforts to improve water quality. An additional 215 miles need attention by 1980, 475 miles by 2000, and 540 miles by 2020. More consideration must be given to the relationship of rangeland use to the attainment of state water quality standards. Poor water quality areas must be identified and specific practices determined to achieve the desired objectives.

In conjunction with requirements for improved erosion and sediment control, about 11 miles of bank stabilization are needed along streams or reservoirs by 1980, some 31 miles by 2000, and 76 miles by 2020. Stream and bank stabilization acreages given elsewhere in this report have been converted to miles on the basis of 10 acres per mile.

To help provide flood control and prevent damage from sediment and debris, an estimated 4 miles of dikes should be constructed in rangeland areas by 1980, 6 miles by 2000, and 8 miles by 2020.

Other Land

There are 714,500 acres of other land at the present time. This is projected to be 765,500 acres by 1980, 822,400 acres by 2000, and 881,600 acres by 2020. Most of this increase is expected to be in urban areas and roads because the population is projected to increase from about 156,000 people in 1966, to 274,000 by 2020. The population increase will, also, demand more recreational areas.

The increased area in roads and urban use will demand more efficient water management practices in irrigation and other uses

of water. The urban areas will require intensified flood protection and sedimentation control. During the construction period, timely stabilization is necessary to insure that no degradation of the resources results from these activities.

MEANS TO SATISFY NEEDS

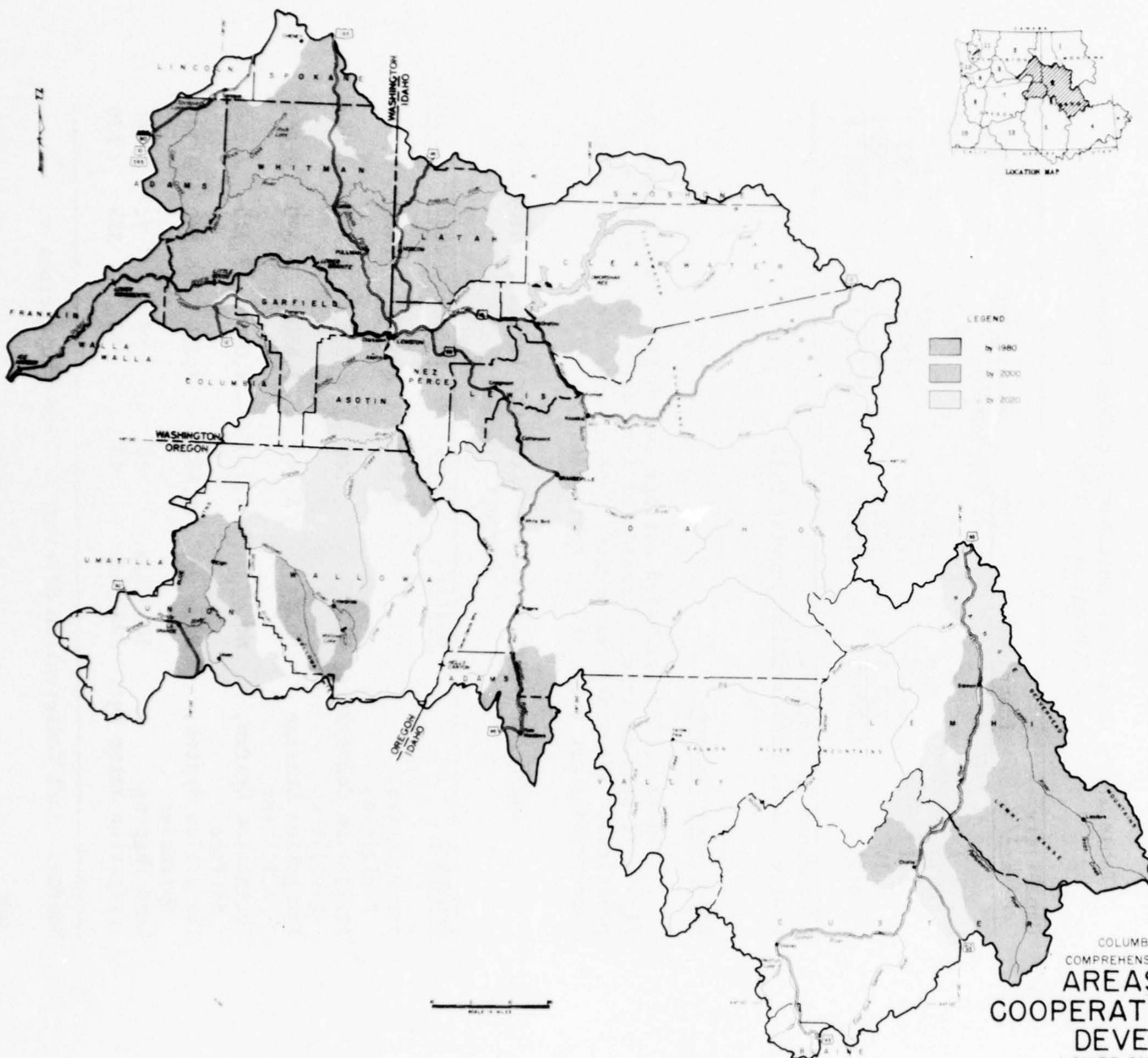
Watershed protection measures will diminish peak flows, reduce sediment production associated with runoff, and will contribute to the control of pollution. The specific means to accomplish watershed protection and management are discussed in terms of individual land treatment measures which are costed in 1969 dollars.

Frequently the most efficient means to satisfy land treatment needs is to apply practices by cooperative efforts of the land owners. Of the 150 watersheds in the subregion, 62 or 41 percent need programs of accelerated planning and treatment for improved watershed protection. The total conservation needs of the watersheds are shown in table 284. Suggested progress of development is illustrated on figure 41.

Table 284 - Practices Required for Cooperative Conservation Development, Subregion 6

Target Date and State	No. Watersheds	Flood Protection	Erosion Control	Drainage	Irrigation New	Irrigation Supplemental	Land Treatment
				(1,000 Acres)			
1980							
Idaho	(3)	3.0	30.4	1.3	13.7	0.1	128.5
Oregon	(4)	0.9	52.2	3.5	16.9	11.4	68.2
Washington	(2)	6.9	113.1	2.0	4.9	0.4	213.4
Total	(9)	10.8	195.7	6.8	35.5	11.9	410.1
No. Watersheds	(9)	(8)	(7)	(7)	(9)	(7)	(9)
2000							
Idaho	(20)	14.0	138.8	33.2	76.4	52.7	629.8
Oregon	(3)	12.5	21.4	11.0	27.6	17.5	56.0
Washington	(13)	72.0	792.4	53.3	173.4	3.6	1,301.3
Total	(36)	98.5	952.6	97.5	277.4	73.8	1,987.1
No. Watersheds	(36)	(28)	(33)	(30)	(32)	(20)	(36)
2020							
Idaho	(11)	5.1	79.5	2.6	28.2	3.1	184.6
Oregon	(1)	1.5	19.2	0.5	16.0	2.0	22.0
Washington	(5)	3.2	77.8	9.0	81.1	0.6	123.6
Total	(17)	9.8	176.5	12.1	125.3	5.7	330.2
No. Watersheds	(17)	(12)	(14)	(10)	(15)	(8)	(17)

Source: Soil Conservation Service, River Basin Survey Data.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

LOWER SNAKE, SUBREGION 6

1968

FIGURE 41

Cropland

The area of cropland is projected to decrease from 3.1 million acres in 1966 to almost 3.0 million acres in 2020. Irrigation is expected to increase from almost 268,000 acres to 743,000 acres in the same period. This land will generally be shifted to other use; however, the total area of potential cropland as outlined in table 285 is greater than the present cropland.

Table 285 - Land Areas Suitable for Crop Production, Subregion 6, 1966

Capability Class 1/	Idaho	Oregon	Washington	Total
		(1,000 Acres)		
I	-	-	3.0	3.0
II	8.0	80.0	336.1	424.1
III	1,034.8	175.0	1,287.6	2,497.4
IV	237.5	172.5	523.4	933.4
Total	1,280.3	427.5	2,150.1	3,857.9

1/ Defined in Glossary.
Source: Soil Conservation Service Data.

Water Conservation

Increases in irrigated acreage and shifts in water application will require intensification of irrigation water management practices. The practices necessary to provide a basis for these improvements are projected in table 286.

Table 286 - Projected Practices for Irrigated Cropland Subregion 6

Practice	Units	1966	1980	2000	2020
Water Control Facilities	No.	4,337	5,380	7,460	9,580
Irrigation Conveyance Facilities	Mi.	749	930	1,290	1,660
Irrigation Storage Facilities	No.	3,104	3,850	5,340	6,860
Irrigation System, Surface	No.	4,730	4,085	3,210	2,360
Irrigation System, Sprinkler	No.	1,550	3,315	6,540	9,740
Land Shaping	1000 Acs.	43	53	74	95
Irrigation Water Mgt.	1000 Acs.	49	180	355	530

Source: Soil Conservation Service, C-NPRBS Projections

The 280 percent increase in water to irrigate new cropland and to furnish additional supply for water-short areas will increase on-farm deliveries 310 percent, while on-farm irrigation efficiencies will increase by 10 percent. Forty-one percent of the irrigation water will be from streamflow, 11 percent from ground water, and 48 percent from storage. Structural measures along with timely land treatment can regulate streamflows and reduce crop damage, erosion, sedimentation, and pollution.

Drainage

Improved drainage will be accomplished by: improved surface drainage to permit farming operations earlier in the season; open drain ditches to lower the water table; improved and additional outlets; construction of sumps and pumping plants; and tile drains to lower the water table, as well as to intercept seepage waters from higher lands. An estimated 60,000 acres of excessively wet arable soils require one or more of these practices. Drainage improvement on about 60 percent of this area will also require flood protection and irrigation water management. Most of the drainage will be accomplished by individual efforts; it may be necessary, in some areas, for owners to group together to provide community outlets. Table 287 shows drainage practices that will be needed to satisfy the cropland drainage needs at the projected rate.

Table 287 - Cumulative Practices Required to Provide Needed Drainage, Subregion 6

Item	Unit	1966	1980	2000	2020
Conduits & Ditches	Miles	1,189	1,620	2,200	2,770
Structures	Number	73	100	140	170

Source: Soil Conservation Service, C-NPRBS Projections.

Erosion and Sedimentation

Larger irrigated acreages and requirements for more intensive use to increase agricultural production will bring attendant requirements for installation of adequate conservation practices to minimize sediment production and water and wind erosion problems. The installation of these practices will reduce the present eroding area of 1.3 million acres to about 231,000 acres. Practices required for erosion control between 1966 and 2020 are shown on table 288.

Table 288 - Cumulative Practices to Satisfy Erosion Control Needs, Subregion 6

Practice	Unit	1966	1980	2000	2020
Conservation Cropping System	1000 acs.	1,120	1,400	1,780	2,160
Crop Residue Use	1000 acs.	1,343	1,680	2,140	2,590
Ditch Bank Seeding	Miles	31	39	49	60
Diversions	Miles	349	440	550	670
Field Windbreaks	Miles	41	50	65	80
Grade Stabilization Structures	Number	80	100	130	150
Grassed Waterways	1000 acs.	7	9	11	14
Pasture and Hayland Planting	1000 acs.	114	140	180	220
Stripcropping	1000 acs.	69	90	110	130
Stubble Mulch	1000 acs.	233	290	370	450

Source: Soil Conservation Service C-NPRBS Projections

The erosion controls measures will be adjusted to the slope, texture, and structure of the soil, and on the crops grown. In Capability Class II cropland on which grain is to be grown, crop residue use and minimum tillage are essential practices. Soils in

Diversion terraces and grassed waterways prevent erosion and remove excess runoff in an orderly manner. (SCS 0-880-11)

Contour stripcropping and summer fallow serves a dual purpose in the dryland farming areas. It conserves moisture in limited rainfall areas and prevents both wind and water erosion. (SCS W-1662-1)

This shelterbelt planting not only provides wind erosion protection, but produces shelter for wildlife. (SCS W-1491-8)

Capability Class III, planted to grain, require structural and vegetative measures as well as cultural practices. Diversions, waterways, and stripcropping will be used to supplement stubble mulching, crop residue use, and minimum tillage. Soils in Capability Class IV growing grain require more intensive use of these same practices and a rotation program with grass or legumes.

Soils that are susceptible to erosion from the wind require similar practices regardless of capability class. Protection from wind erosion is accomplished by reducing wind velocity at the surface of the field with practices such as stubble mulching, cloddy tillage, wind stripcropping, wind breaks, and minimum tillage.

Flooding

More intensive use of all land and water resource will require additional flood protection measures. The most critical needs will be in the urban, industrial, and intensively cropped areas. The channel work and diking necessary to provide this protection are shown in table 289.

Table 289 - Cumulative Cropland Flood Prevention Practices
Subregion 6

Practice	1966	1980	2000	2020
		(Miles)		
Stream Channel Improvement	229	360	530	700
Stream Channel Stabilization	2	4	7	10
Streambank Protection	24	37	54	70
Dikes & Levees	21	31	46	60

Source: Soil Conservation Service, C-NPRBS Projections.

Storage is another alternative for flood protection. This method is beneficial in that it can control or regulate high intensity, short duration floods. It also provides additional multipurpose benefits for other types of water uses, such as irrigation, municipal and industrial development, pollution control, fish and wildlife enhancement, and recreational demands.

Croplands require treatment measures in relation to the intensity of use and production requirements. The goal is optimum production with a minimum of soil and water loss.

Program Cost

The costs of implementing conservation practices discussed in the previous sections are scheduled in table 290. The costs are based on constant 1969 dollars. The cost of technical time that will be necessary to carry on conservation programs at the projected rate have been estimated. Approximately 16 percent of the total dollars needed between 1966 and 2020 will be furnished from public funds.

Table 290 - Estimated Cost of Cropland Conservation Practices, Subregion 6

Item	Water Conservation	Drainage	Erosion Control	Flood Control	Total
			($1,000)		
1966-1980					
Private Funds	165,186	3,969	91,860	3,780	264,795
Public Funds	35,224	1,701	5,860	8,036	50,821
Technical 1/	4,870	1,020	4,130	950	10,970
Total	205,280	6,690	101,850	12,766	326,586
1981-2020					
Private Funds	338,450	7,700	165,620	8,100	519,870
Public Funds	65,490	3,300	10,570	17,210	96,570
Technical 1/	10,990	1,980	7,430	2,020	22,420
Total	414,930	12,980	183,620	27,330	638,860
2001-2020					
Private Funds	455,580	10,017	204,930	11,180	681,707
Public Funds	82,890	4,293	13,080	23,760	124,023
Technical 1/	16,140	2,570	9,200	2,800	30,710
Total	554,610	16,880	227,210	37,740	836,440

1/ Includes public and private costs.
Source: Soil Conservation Service, C-NPRBS Projections.

Forest Land

The demand for timber products is directly related to sustained yield capacity. This demand is expected to increase by almost 30 percent in the next 50 years. Since this demand for timber products will increase harvest activities and since other associated uses will likewise increase, planning for watershed protection takes on added importance. This planning must consider not only the safe optimum use of forest lands under all uses, but also the production of clean water. Planning must make these practices a part of the orderly development of vegetative and structural programs of the subregion.

Watershed Protection

It is anticipated that the intensity of watershed protection conducted currently with logging and road construction, as outlined in table 270, will accelerate on the public forest lands. A level at least equal to that presently used on public lands, will be necessary for the private areas, especially on sites with a high erosion or sediment yield potential. Table 291 outlines the required watershed protection practices and the anticipated total cost of such measures, accumulated through the year 2020. These costs are based on the assumption that: (1) on the public forest lands, controls through timber sale and construction contracts are adequate if properly applied, and (2) on the private forest lands, the minimum required will be about equal that presently in effect on the public lands.

Table 291 - Projected Costs for Watershed Protection Practices, Forest Land, Subregion 6

Practices	Unit	Total Units 1/	Total Cost 1/ $1,000
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	232,200	6,966
Harvest Road Treatment 2/	Mi.	23,200	5,800
Other Watershed Requirements 3/	Ac.	11,687,000	181,350
Total Cost			194,116
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	69,800	1,745
Harvest Road Treatment	Mi.	7,000	1,400
Other Watershed Requirements	Ac.	1,812,000	39,260
Total Cost			42,405
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	302,000	8,711
Harvest Road Treatment	Mi.	30,200	7,200
Other Watershed Requirements	Ac.	13,499,000	220,610
Total Cost			236,521

1/ Total for 55-year period 1965-2020. Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, special road requirements, and other indirectly related items.

At this rate, application of the recurrent watershed protection measures will cost about $4,200,000 annually on the public forest lands and should cost $1,100,000 annually on the private lands. Converting the annual costs to totals, this amounts to $289,918,000. This represents the cost of maintaining the productive condition of the forest watersheds under the pressure of projected demands.

Watershed Rehabilitation

The forest areas most in need of rehabilitation are the areas in the "medium" through "very high" yield categories listed in table 269. These areas are presently contributing over 550 acre-feet per year. Treatment needs and the amount that should be accomplished during time periods 1980, 2000, and 2020 are listed on table 292. The expected sediment reduction accomplished by these measures is listed in table 293.

Table 292 - Projected Watershed Rehabilitation Programs, Forest Land, Subregion 6

Program	Unit	1980 Amount	1980 Cost1/	2000 Amount	2000 Cost1/	2020 Amount	2020 Cost1/
			$1,000		$1,000		$1,000
			FEDERAL LANDS				
Land Treatment	Acres	23,000	2,526	43,700	5,164	74,300	8,836
Stream Rehabilitation	Miles	710	4,428	609	3,796	105	634
Road Rehabilitation	Miles	2,579	7,127	568	1,427	56	1
Total Cost			14,081		10,387		9,471
			NON-FEDERAL LANDS				
Land Treatment	Acres	30,500	2,440	41,000	3,280	52,000	4,160
Stream Rehabilitation	Miles	55	252	56	257	65	279
Road Rehabilitation	Acres	161	8	262	12	264	14
Total Cost			2,700		3,549		4,453
			TOTAL ALL LANDS				
Land Treatment	Acres	53,500	4,966	84,700	8,444	126,300	12,996
Stream Rehabilitation	Miles	765	4,680	665	4,053	170	913
Road Rehabilitation	Acres	2,740	7,135	830	1,439	320	15
Total Cost			16,781		13,936		13,924

1/ In 1969 Dollars

The overall expected sediment reduction is 38 percent, or 460 acre-feet per year, representing that produced mostly by the high and very high yield areas.

In addition to the needs for sediment reduction on the presently eroding forest land, nonrecurrent work will be required on any future extensive or large forest burns and lands directly related to future water storage projects. These sediment sources

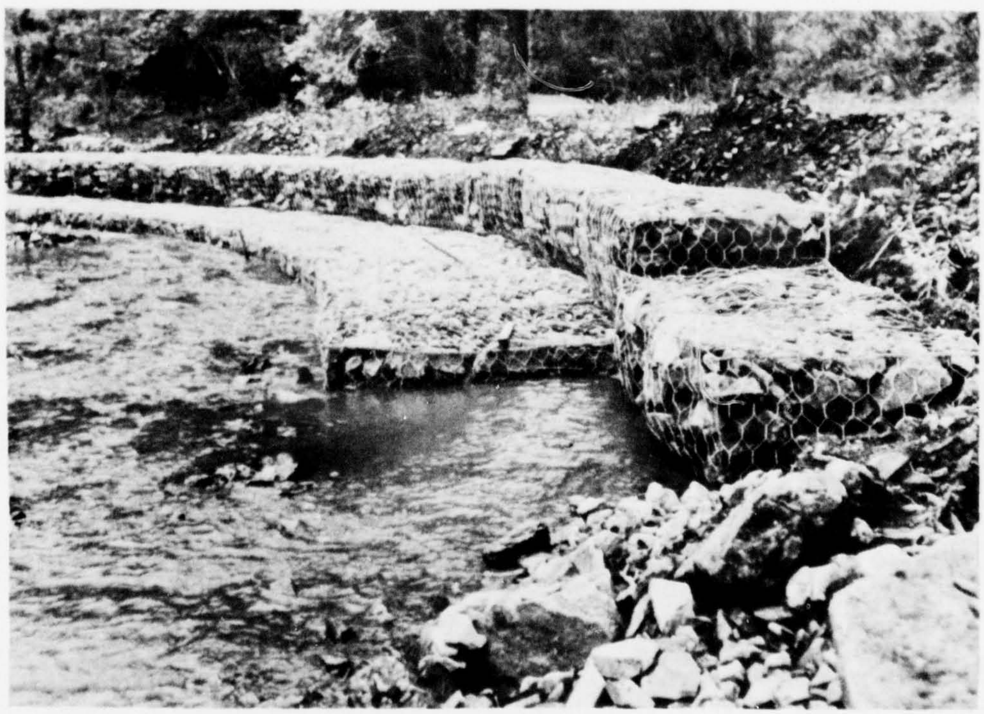
will be treated when needed. Therefore, the 38 percent overall sediment reduction is that amount possible should no new source occur through catastrophic fire or other natural disaster.

Table 293 - Expected Annual Sediment Reduction
Forest Land Rehabilitation, Subregion 6

Present Yields	Acres (1,000)	Total Sed. Yield Ac.-ft/yr.	Acres Treated 2/	Sediment Reduction Ac.-ft/yr.
Very low	11,025.9	345	--	--
Low	2,040.2	319	--	--
Medium	16.6	5	--	--
High	325.1	254	317,000	198.0
Very High	129.3	303	129,000	262.6
	13,537.1	1,226		460.6

Total reduction, percent 38

1/ Data from table 269.
2/ Data from table 292. Miles treated converted to acres.



Wire and rock gabions are used to stabilize streambanks. (Forest Service)

Water Yield Improvement

The projected water yield improvement programs needed and the amount that should be accomplished by time periods 1980, 2000, and 2020 are listed in table 294. Timber harvest on the private forest lands is adjusted principally to meet production requirements. Therefore, neither water yield improvement practices nor benefits are estimated, although some benefit does occur.

Table 294 - Projected Water Yield Improvement Practices Public Forest Land, Subregion 6

Program	Unit	1980 Amount	1980 Cost 1/ $1000	2000 Amount	2000 Cost 1/ $1000	2020 Amount	2020 Cost 1/ $1000
Cover Manipulation 2/	Acres	11,000	315	15,000	450	22,000	660
Snowpack Management	Miles	100	5,000	150	7,500	165	8,250
Water Spreading 3/	Acres	2,000	594	2,500	743	2,800	832
Total Cost			5,909		8,693		9,742

1/ In 1969 dollars.
2/ Includes type conversion and riparian vegetation management.
3/ Planned for altering timing of runoff or ground-water recharge, not for irrigation or other resource activity.

Total Program Costs

In summary, the total cost of forest watershed protection and land treatment programs through the year 2020 may be expressed as follows:

	Costs $1,000
Watershed Protection	$289,918
Watershed Rehabilitation	44,641
Water Yield Improvement	24,344
	$358,903

Rangeland

Measures and Practices for Watershed Protection

Watershed practices to satisfy future needs for rangeland watershed protection, rehabilitation, and improvement in Subregion 6 are listed in tables 295, 296, 297. Most of these measures which improve watershed conditions also have other management objectives or purposes.

Table 295 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Subregion 6 1/

Measures & Practices	Units	Land Ownership Public 3/	Private	Total	Watershed Purposes 2/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	39,500	41,300	80,800	-	x	x	x
Brush Control	Acres	85,600	89,700	175,300	-	x	x	-
Weed Control	Acres	35,800	37,400	73,200	-	x	x	-
Fertilizing	Acres	10,400	10,900	21,300	-	-	x	-
Contouring, Pitting, Furrowing	Acres	14,500	15,100	29,600	-	x	x	-
Stream & Bank Stabilization	Acres	55	55	110	-	x	x	x
Waterspreading	Acres	170	180	350	-	x	x	x
Irrigation	Acres	200	200	400	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,200	1,200	2,400	-	x	x	-
Reducing Excessive Grazing Use	Acres	29,500	30,900	60,400	-	x	x	-
Livestock & Game Water Facilities	Number	1,200	1,300	2,500	-	x	x	-
Special Fire Control	Acres	4,600	4,900	9,500	-	x	x	-
Road Stabilization								
Existing Roads	Miles	250	270	520	-	x	x	-
New Roads	Miles	50	60	110	-	x	x	-
Stream Clearance	Miles	12	13	25	-	x	x	-
Pollution Abatement	Miles	90	100	190	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	300	300	600	-	x	x	-
	Acre Ft.	300	300	600	-	x	x	-
Detentions	Number	30	30	60	-	x	x	x
	Cu. Yds.	340,200	356,200	696,400	-	x	x	x
Check Dams (Gully Plugs)	Number	200	200	400	-	x	x	x
	Cu. Yds.	175,300	183,600	358,900	-	x	x	x
Dikes	Lin. Ft.	10,400	10,900	21,300	-	x	x	x
Diversions	Number	3	3	6	-	x	x	x
	Cu. Yds.	58,400	61,200	119,600	-	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.

Table 296 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1981 to 2000, Subregion 6 1/

Measures & Practices	Units	Land Ownership Public 3/	Private	Total	Watershed Purposes 2/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	44,300	46,400	90,700	-	x	x	x
Brush Control	Acres	116,900	122,400	239,300	-	x	x	-
Weed Control	Acres	61,100	64,000	125,100	-	x	x	-
Fertilizing	Acres	16,200	17,000	33,200	-	-	x	-
Contouring, Pitting, Furrowing	Acres	24,100	25,200	49,300	-	x	x	-
Stream & Bank Stabilization	Acres	100	100	200	-	x	x	x
Irrigation	Acres	220	230	450	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,400	1,500	2,900	-	x	x	-
Livestock & Game Water Facilities	Number	1,000	1,100	2,100	-	x	x	-
Special Fire Control	Acres	18,500	19,400	37,900	-	x	x	-
Road Stabilization								
Existing Roads	Miles	95	100	195	-	x	x	-
New Roads	Miles	35	37	72	-	x	x	-
Abandoned Roads	Miles	20	20	40	-	x	x	-
Pollution Abatement	Miles	130	130	260	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	300	300	600	-	x	x	-
	Acre Ft.	300	300	600	-	x	x	-
Detentions	Number	40	40	80	-	x	x	-
	Cu. Yds.	525,400	550,100	1,075,500	-	x	x	-
Check Dams (Gully Plugs)	Number	200	200	400	-	x	x	x
	Cu. Yds.	89,700	93,900	183,600	-	x	x	x
Dikes	Lin. Ft.	4,600	4,800	9,400	-	x	x	x
Diversions	Number	2	2	4	-	-	x	-
	Cu. Yds.	600	600	1,200	-	-	x	-

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.

Table 297 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2001 to 2020, Subregion 6 1/

Measures & Practices	Units	Land Ownership			Watershed Purposes 2/			
		Public 3/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	29,500	30,900	60,400	-	x	x	-
Brush Control	Acres	128,400	134,500	262,900	-	x	x	-
Weed Control	Acres	70,100	73,400	143,500	-	x	x	-
Fertilizing	Acres	16,200	17,000	33,200	-	-	x	-
Contouring, Pitting, Furrowing	Acres	38,000	39,700	77,700	-	x	x	-
Stream & Bank Stabilization	Acres	220	230	450	-	x	x	-
Irrigation	Acres	200	200	400	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,400	1,400	2,800	-	-	x	-
Livestock & Game Water Facilities	Number	1,000	1,000	2,000	-	-	x	-
Special Fire Control	Acres	17,400	18,200	35,600	-	x	x	-
Road Stabilization								
Existing Roads	Miles	25	25	50	-	-	x	-
New Roads	Miles	30	30	60	-	x	x	-
Stream Clearance	Miles	12	13	25	-	-	x	-
Pollution Abatement	Miles	20	20	40	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	300	300	600	-	x	x	-
	Acre Ft.	300	300	600	-	x	x	-
Detentions	Number	50	60	110	-	x	x	-
	Cu. Yds.	761,400	797,300	1,558,700	-	x	x	-
Check Dams (Gully Plugs)	Number	170	170	340	-	x	x	x
	Cu. Yds.	72,300	75,700	148,000	-	x	x	x
Dikes	Lin. Ft.	4,600	4,800	9,400	-	x	x	x
Diversions	Number	2	2	4	-	-	x	-
	Cu. Yds.	600	600	1,200	-	-	x	-

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.

Cover improvement and soil stabilization practices should cover a total of 1.5 million acres between 1966 and 2020. Some will be recurring efforts, and a combination of practices will be applied on certain range areas. An estimated 70 percent of the 232,000 acres of grass and shrub seeding and 678,000 acres of brush control will be for watershed improvement. Other significant soil stabilizing requirements include 157,000 acres of contouring, some 75 miles of bank stabilizing along streams or reservoirs, and water spreading on 350 acres.

Additional watershed and soil surveys must be made to provide guidance for more comprehensive watershed management. Less than 1.0 million acres of rangeland are covered by soil surveys, and a total of about 2.7 million acres should be mapped by 2020, including intensive updating of previous surveys. Watershed plans now cover an estimated 2.1 million acres of rangeland; by 2020, this should be increased to 2.4 million acres including appropriate adjustments and revisions of existing plans.

Of major importance in the next 50 years is the continual development of grazing management systems to increase range grazing capacity while providing adequate cover for soil stability and watershed protection. Better livestock distribution and protection of areas having particular wildlife values will require construction

of about 8,100 miles of livestock fence and development of an additional 6,600 livestock and game water facilities.

Control of range fires is essential to protection of the forage crop and watershed cover and special fire prevention measures will be required on 83,000 acres, including extra fire patrol, fire breaks, development of facilities for water supply for fire control, and specific measures to preserve litter on the soil to prevent siltation and contamination of water from burned areas. About 750 miles of existing range roads, 250 miles of new roads, and 40 miles of abandoned roads will need ditches and culverts to control runoff and other practices to stabilize watershed soils. Some 50 miles of waterways in the subregion need stream clearance, and pollution abatement work should be accomplished along approximately 500 miles of streams by 2020.

Necessary water control structures between 1966 and 2020 include about 1,800 ponds and small reservoirs with a total storage capacity of some 1,800 acre-feet, 265 detention or diversion dams, 1,100 check dams, and about 8 miles of dikes.

Overgrazing has depleted much of the protective grass cover on this rangeland slope in the Wallowa-Whitman National Forest, leaving it unprotected and subject to erosion. Land treatment practices are indicated and livestock should be excluded while cover is being restored. (Forest Service)

Erosion and Sediment Yield Improvement

Range areas in the "Very High, "High," and "Medium" sediment yield categories (table 273) represent about 18 percent of the total rangeland, but annually contribute about 1,630 acre-feet of sediment or 67 percent of the total sediment load. Erosion and water quality control practices, shown on tables 295, 296, and 297, will be concentrated primarily on these areas. Redistribution of grazing use and improved vegetative cover should result in reduction of approximately 54 percent of the annual sediment yield from 2,154 acre-feet in 1966 to 981 acre-feet by 2020 (table 298).

Table 298 - Sediment Yield Projections from Rangeland, Subregion 6

Sediment Yield 1/ Categories	1966	1980	2000	2020
		Rangeland Acreage (1,000 Acres)		
Very Low	3,205.0	3,313.7	3,579.7	3,831.1
Low	951.0	765.9	497.1	240.1
Medium	260.5	291.8	349.4	404.1
High	438.4	368.0	268.0	172.3
Very High	186.9	139.0	68.0	--
Total	5,041.8	4,878.4	4,762.2	4,647.6
Percent Change from 1966	.0	-3.4	-5.6	-7.8
		Annual Sediment Yield (Acre-Feet)		
Very Low	301	311	336	359
Low	223	179	116	57
Medium	142	159	191	221
High	685	575	419	269
Very High	803	598	292	--
Total	2,154	1,822	1,354	906
Percent Change from 1966	.0	-15.4	-37.1	-57.9

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.

Headcutting in Malm Gulch, located in the Upper Salmon River area, is caused by rapid runoff from a denuded watershed as shown in the background. This indicates the need for increased ground cover for soil stabilization and detention structures in the channel. (Bureau of Land Management)

Improved Range Condition and Capacity

Estimated future range improvement, given on table 299, will result partly from accomplishment of watershed protection measures, shown in tables 295, 296, and 297, and partly from other range management practices for improved forage production. In 1966, only 25 percent of the rangeland was in good range condition. With scheduled improvements, good condition range will be increased to 64 percent by 2020, or from 1.3 million acres to 3.2 million acres. Poor condition range which in 1966 accounted for 34 percent of the total land will be decreased to 14 percent by 2020 (from 1.7 million acres to 700,000 acres). The 1966 grazing capacity of 820,000 animal unit months is expected to rise by 50 percent to 1.2 million animal unit months in 2020.

Even with this improvement in range condition and grazing capacity, range forage production will only meet about 8.5 percent of the anticipated demand for livestock production in Subregion 6 by 2020 compared to 12.9 percent in 1966.

Table 299 - Estimated Potential Rangeland Improvement, Subregion 6

Range Type and Condition	1966 Acres (1,000)	1966 AUMs (1,000)	1980 Acres (1,000)	1980 AUMs (1,000)	2000 Acres (1,000)	2000 AUMs (1,000)	2020 Acres (1,000)	2020 AUMs (1,000)
Grassland								
Good	713.1	237.7	972.9	324.3	1,316.5	438.8	1,809.1	603.0
Fair	1,300.8	200.1	1,147.2	176.5	986.7	151.8	697.8	107.3
Poor	1,069.6	85.5	920.1	73.6	682.5	54.6	451.0	36.1
Seeded Range	217.9	87.2	288.2	115.3	376.8	150.8	421.0	168.4
Total	3,301.4	610.5	3,328.4	689.7	3,362.5	796.0	3,378.9	914.8
Sagebrush								
Good	272.4	68.1	408.7	102.2	708.5	177.1	904.0	226.0
Fair	682.5	80.3	600.0	70.6	391.7	46.1	295.3	34.7
Poor	541.9	31.0	459.4	26.2	331.9	18.9	214.5	12.3
Total	1,496.8	179.4	1,468.1	199.0	1,432.1	242.1	1,413.8	273.0
Other Brush								
Good	49.2	14.0	64.6	18.4	88.6	25.3	113.8	32.5
Fair	102.6	13.0	96.5	13.0	101.1	12.8	94.6	12.0
Poor	91.8	3.1	82.6	2.8	53.7	1.8	34.9	1.2
Total	243.6	30.1	243.5	34.2	243.4	39.9	243.3	45.7
Total								
Good[1/]	1,252.6	407.0	1,734.4	560.2	2,490.4	792.0	3,247.9	1,029.9
Fair	2,085.9	293.4	1,843.5	260.1	1,479.5	210.7	1,087.7	154.0
Poor	1,703.3	119.6	1,462.1	102.6	1,068.1	75.3	700.4	49.6
Grand Total	5,041.8	820.0	5,040.0	922.9	5,038.0	1,078.0	5,036.0	1,233.5
Average AC/AUM	6.1		5.5		4.7		4.1	
Percent Change from 1966	.0	.0	.0	+12.5	-.1	+31.5	-.1	+50.4

1/ Includes seeded range.
Source: Table 272 "Present Status" rangeland narrative. Future estimates for this study are based on representative on-site surveys for production guides with consideration to the capability of the range for improvement with proper management and utilization.

Estimated Program Costs

Broad investment cost estimates (based on 1969 dollars) are shown on table 300 for future watershed protection and rehabilitation of rangeland. Cover improvement and soil stabilization practices will cost $6.2 million between 1966 and 2020, or 38 percent of the total rangeland watershed program. About $6.6 million or 40 percent is needed for watershed oriented land management efforts, and water control structures require $3.6 million or 22 percent of total costs. Based on the present ratio of rangeland ownership, future dollar needs for watershed purposes will be about equally divided between public and private lands.

Table 300 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Subregion 6 1/

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
		Public Land		
Cover Improvement and Soil Stabilization	727.2	1,023.6	1,326.5	3,077.3
Watershed Oriented Land Management Practices	989.5	1,308.7	1,019.0	3,317.2
Water Control Structures	531.7	613.3	630.6	1,775.6
Total	2,248.4	2,945.6	2,976.1	8,170.1
		Private Land		
Cover Improvement and Soil Stabilization	755.1	1,036.3	1,385.3	3,176.7
Watershed Oriented Land Management Practices	1,012.1	1,409.3	819.9	3,241.3
Water Control Structures	541.1	622.9	642.2	1,806.2
Total	2,308.3	3,068.5	2,847.4	8,224.2
		Total		
Cover Improvement and Soil Stabilization	1,482.3	2,059.9	2,711.8	6,254.0
Watershed Oriented Land Management Practices	2,001.6	2,718.0	1,838.9	6,558.5
Water Control Structures	1,072.8	1,236.2	1,272.8	3,581.8
Total	4,556.7	6,014.1	5,823.5	16,394.3

1/ Based on measures and practices shown on tables 295, 296, and 297, with constant 1969 dollars.

Other Land

Other land is projected to increase over 167,000 acres by the year 2020. The increase will be for home and industrial sites, roads, recreation areas, and water. The area of barren land is expected to remain about the same. Erosion is a major problem during the time of transition from cropland, forest land, or rangeland to more itensive use.

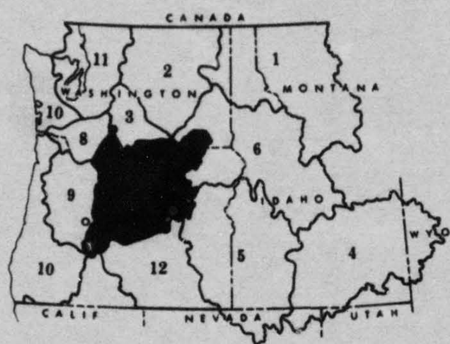
Advanced planning will be necessary to alleviate problems caused by urban expansion and development. Almost 1,800 acres of urban area are subject to flooding and some areas have problems with erosion, drainage, and sedimentation. There are other problems to be resolved, such as water supply and sewage disposal in urban and industrial areas, erosion and sedimentation on roads, and erosion, drainage, and sedimentation in recreational areas.

Flood protection for other land which is presently flooded can be greatly enhanced by flood dentention reservoirs, by enlarged

or improved channels, and by dikes and levees. Land treatment measures on adjacent cropland, forest land, and rangeland are also essential.

Soil surveys and interpretive analysis of the surveys will provide a basis for safe expansion of other land. Soils studies can indicate the hazards of land use for certain developments and measures necessary to overcome these problems.

Sediment which causes damage to urban areas, roads, and other developments, generally originate on adjacent cropland, forest land, and rangeland. Treatment of these lands as discussed in the respective sections is very important to the protection of other lands from sediment damages. It is, therefore, evident that many of the structures and land management measures necessary to provide watershed protection and improvement of other land have been included and costed elsewhere in this appendix and in Appendices VII, Flood Control; IX, Irrigation; XI, Municipal and Industrial Water Supply; and XII, Water Quality and Pollution Control.



LOCATION MAP

SUBREGION 7

S U B R E G I O N 7
M I D C O L U M B I A

PRESENT STATUS

Subregion 7, the Mid Columbia, contains 18,947,800 acres, occupying about 11 percent of the region. This includes a land area of 18.8 million acres and almost 126,000 acres of large water bodies. About 58 percent of the land area is privately owned. The balance is public. Nearly 60 percent of this is in national forest status.

Precipitation varies considerably over the subregion. Near the mouth of the Umatilla River, the average annual precipitation is only 7 inches, while at some locations along the Cascade Mountains crest to the west annual precipitation exceeds 130 inches. Snowfall constitutes most of the precipitation at higher elevations but is irregular at lower elevations. Although most of the precipitation occurs in the winter, the subregion experiences intense summer convection storms, some of which have been extremely damaging.

Average discharge of streams originating in the subregion amounts to 10.0 million acre-feet annually. About 8.5 million acre-feet (85 percent) flow from forest areas, the remaining 1.5 million acre-feet from crop and rangeland (figure 42).

Highest sediment yields are from the cropland areas, particularly the Palouse country in the northeast corner of the subregion. Nearly 70 percent of the total yield is produced from this use. Temporary high yields sometimes result from logging, grazing, and other land uses (table 301 and figure 44).

Table 301 - Generalized Sediment Yield by Cover and Land Use, Subregion 7

Cover and Land Use	Acres 1,000	Percent	Sediment Yield Ac-Ft./Year	Percent
Cropland	3,570.6	19	4,145	68
Forest Land	8,328.3	44	509	8
Rangeland	6,358.1	34	1,252	21
Other Land	565.2	3	172	3
Total	18,822.2	100	6,078	100

Source: Derived from figures 43 and 44 and Appendix IV.

EXPLANATION

MEAN ANNUAL RUNOFF

▲ STREAM GAGE (RECORDING)

NOTES

1. MEAN ANNUAL RUNOFF ISOPLETHS HAVE BEEN DRAWN BY U.S. GEOLOGICAL SURVEY USING OBSERVED STREAMFLOW DATA ADJUSTED TO NATURAL CONDITIONS (1931-1960) AND CORRELATED WITH CLIMATOLOGICAL AND PHYSIOGRAPHIC FACTORS
2. STATIONS INDICATED DO NOT INCLUDE ALL OF THOSE USED IN PREPARING THE MAP

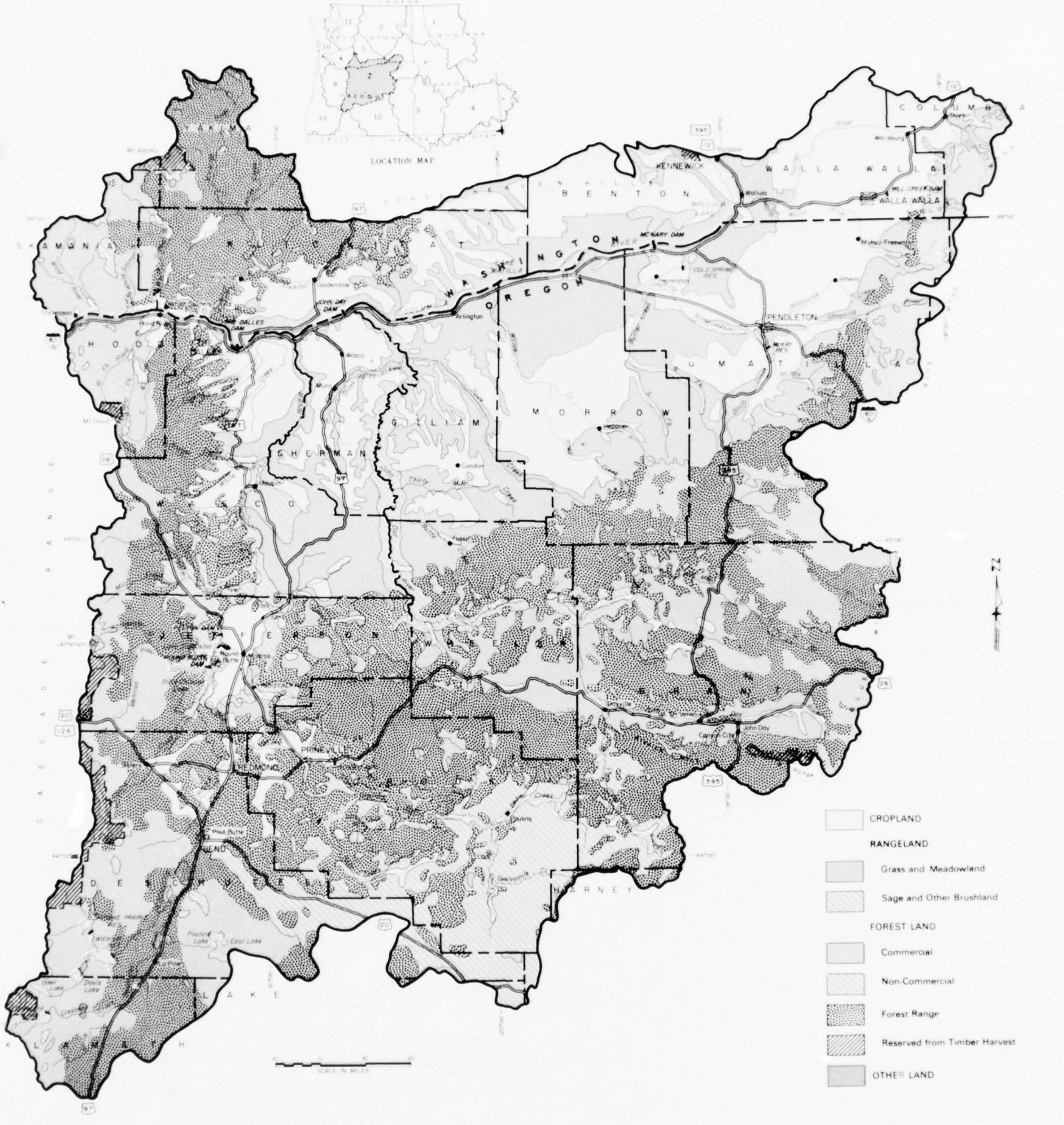
COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL RUNOFF IN INCHES

MID COLUMBIA SUBREGION 7

1968

FIGURE 42

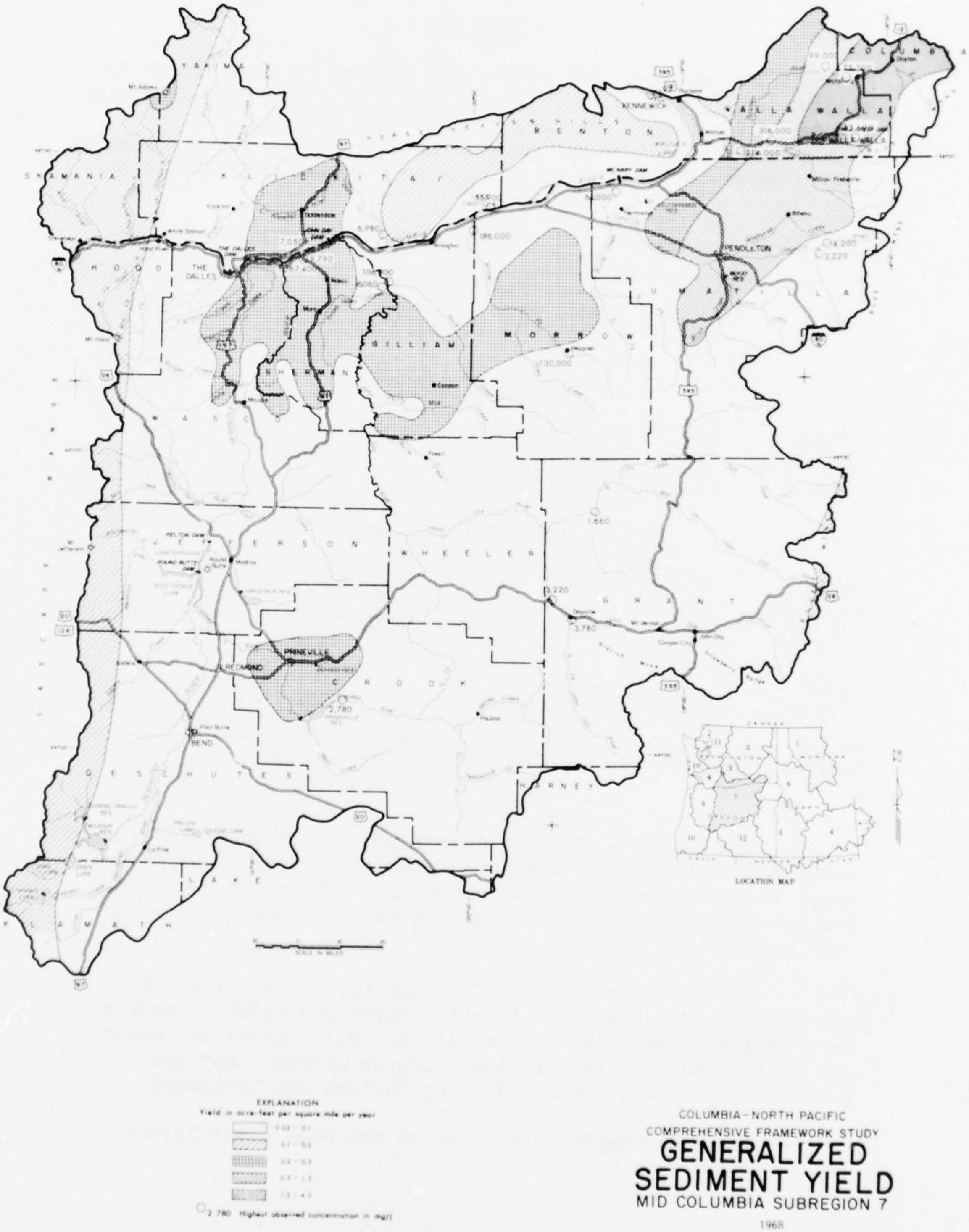


COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED COVER AND LAND USE

MID COLUMBIA, SUBREGION 7
1968

FIGURE 43



COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

MID COLUMBIA SUBREGION 7

1968

FIGURE 44

Cropland

The subregion has over 9,000 farm units with almost 3.6 million acres of cropland. There is a wide variation in growing seasons which range from less than 80 days for cropland on higher benches to over 210 days on bottomlands near the Columbia River. Types of crops grown in this area are shown in table 302.

Table 302 - Types of Crops, Subregion 7, 1966

State	Hay & Pasture	Small Grain	Grain & Peas	Row Crops	Orchard	Other	Cropland Area
	1000 Acres						
			Dry Cropland				
Oregon	136.7	1,557.5	180.8	--	0.5	--	1,875.5
Washington	57.4	1,086.7	19.5	--	6.1	--	1,169.7
Total	194.1	2,644.2	200.3	--	6.6	--	3,045.2
			Irrigated Cropland				
Oregon	355.9	18.1	--	31.7	31.1	8.1	444.9
Washington	58.2	9.9	--	10.3	2.1	--	80.5
Total	414.1	28.0	--	42.0	33.2	8.1	525.4
Total Cropland	608.2	2,672.2	200.3	42.0	39.8	8.1	3,570.6

Source: Appendix IV, Land and Mineral Resources

Environmental factors associated with elevation, climate and water availability have influenced the distribution of crop types in various areas of the subregion. The upper watershed and some bottomlands grow hay and pasture to supplement rangeland production.

The Columbia Basin, with a growing season from 160 to 180 days, is an area about 40 miles north and south extending from Pendleton westward to The Dalles. Major crops are wheat and barley under a grain-fallow cropping system. Hay and pasture crops along creek and river bottoms are irrigated.

Pears and apples are grown in the Hood River Valley;

while cherries, peaches and apricots are raised near The Dalles. Also produced are berries, predominately strawberries, and some small grains. Hay and pasture, usually found on the bottomlands, is mostly irrigated.

The Milton-Freewater, Hermiston, and Walla Walla areas grow a number of crops; these include wheat, mellons, peas, peaches, apples, pears, prunes, tomatoes, sweet corn, and asparagus. On the foothills of the Blue Mountains east of Pendleton and Walla Walla where precipitation is above 16 inches, green peas, in rotation with wheat, are grown. The White Salmon-Klickitat area has some irrigated hay and pasture along stream bottoms, but the major hay and pasture producing areas are non-irrigated in a precipitation range above 20 inches. There are approximately 6,500 acres of nonirrigated orchards and approximately 200 acres of irrigated orchards in this area.

Water Conservation

Problems in water conservation result from the seasonal distribution of precipitation and the variation in annual amounts. In most areas, where spring runoff is not stored in reservoirs, streamflows are drastically reduced before the growing season is over. Considerable work has been done by landowners to overcome these problems. This includes construction of storage facilities, water control and conveyance facilities, irrigation systems, and irrigation water management (table 303).

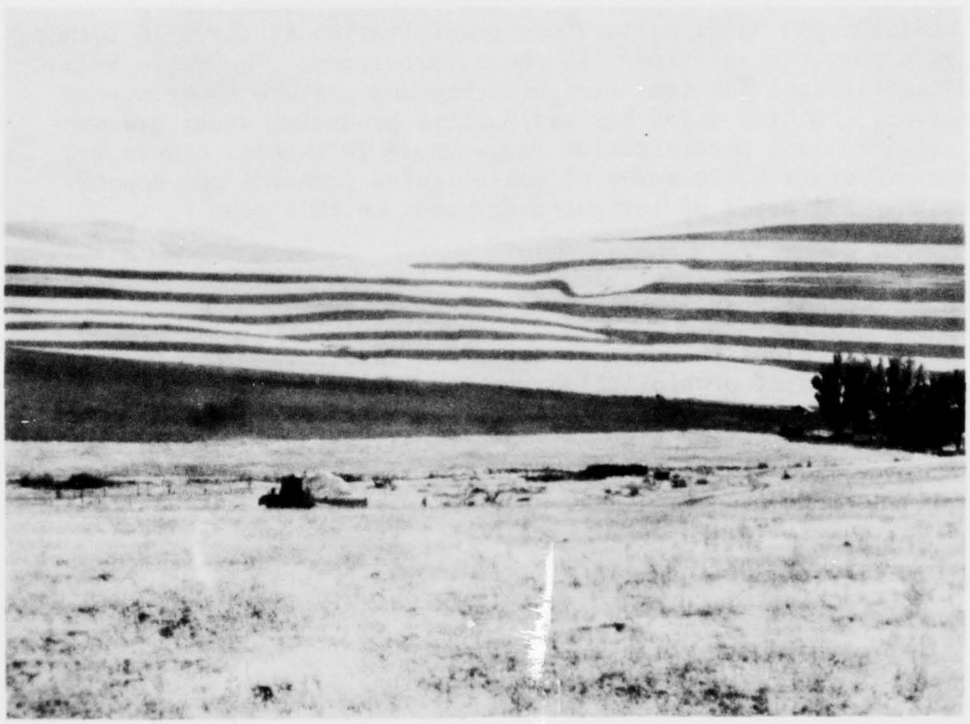
Table 303 - Water Conservation Practices Applied on Cropland, Subregion 7, 1966

Practice	Unit	Oregon	Washington	Total
Water Control Facilities	No.	21,298	1,921	23,219
Water Storage Facilities	No.	2,500	509	3,009
Irrigation Water Conveyance Facilities	Miles	3,483	1,600	5,083
Irrigation System, Surface and Subsurface	No.	535	1,453	1,988
Irrigation System, Sprinkler	No.	933	873	1,806
Land Shaping	1000 Acs.	62.2	41.4	103.6
Irrigation Water Management	1000 Acs.	43.7	68.9	112.6

Source: USDA, Soil Conservation Service Data

There are a number of dryland erosion control practices installed that also conserve water; these include stripcropping,

stubble mulching, diversion terraces and subsoiling. Contour stripcropping is generally found on slopes from 5 to 18 percent and consists of a strip of small grain and a strip of fallow. This provides alternate strips under vegetative cover, reducing or preventing erosion and allowing more water to enter the soil.



Contour stripcropping reduces wind and water erosion. (SCS 0-866-11)

Stubble is usually left standing through winter, and weeds are controlled through tillage the following summer. Seeding is done in the fall. Since fallow areas provide a strip without growing vegetation for a full year, the moisture content of the soil builds up to field capacity. When rain occurs with soils at field capacity, moisture is lost through deep percolation, by lateral movement or surface runoff.

Stubble mulching is primarily an erosion control practice. However, straw reduces puddling on the soil surface during rainstorms, slows velocities of surface flows and

reduces wind velocities on the surface. In addition, there is a reduction in moisture loss through evaporation.

Diversion terraces are constructed to reduce the length of slope and reduce erosion. Since the length of slope is less, runoff consists mostly of sheet type flow and more water infiltrates the soil.

Of the 525,400 acres of irrigated cropland, streamflow provides water for 341,600 acres. Since most streamflow is derived from snowmelt, streams have more than ample flow early, but the supply dwindles during the irrigation season. About 46 percent of the acreage irrigated is short of water. Water availability and irrigation use are shown in table 304.

Table 304 - Water Availability and Irrigation Use, Subregion 7, 1966 1/

Item	Oregon	Washington	Total	Percent
	-----------------1000 Acres-----------------			
Water Source				
Streamflow	278.7	62.9	341.6	65
Groundwater	28.8	13.6	42.4	8
Reservoir Storage	137.4	4.0	141.4	27
Total	444.9	80.5	525.4	100
Area with Adequate Supply	229.6	52.9	282.5	54
Area with Inadequate Supply	215.3	27.6	242.9	46
Method of Application				
Sprinkler	81.1	42.8	123.9	24
Flooding	363.8	37.7	401.5	76

Source: Soil Conservation Service, C-NPRB Data
1/ Approximately 97% of acreage in Appendix IX

Subsoiling breaks compacted layers in the soil that have been formed through tillage operations or by soil forming processes. This allows more precipitation to enter the soil reducing erosion and conserving moisture.

Drainage

Prior to irrigation, poor drainage was confined mostly to wet meadows in mountainous areas and a few areas along stream flood plains. With the advent of irrigation, drainage problems

have increased. At present, 57,800 acres have a wetness problem (table 305). Of this, 17,300 acres have been drained to a degree suitable for its present use, and 40,500 acres still need drainage.

Table 305 - Cropland Areas with a Wetness Problem
Subregion 7, 1966

Capability Class	Oregon	Washington	Area (1000 Acres)
II	--	--	--
III	12.5	--	12.5
IV	45.3	--	45.3
Total	57.8	--	57.8

Source: Soil Conservation Service, C-NPRBS Data

Drainage problems on level to nearly level benches are usually associated with a high water table. In these areas underlying material, usually basalt or cemented hardpan, does not allow deep percolation of excess water from over-irrigation. Only rarely are seeps from adjacent hillsides a problem to cropland.

Excessively wet soils in the upper watersheds are scattered along bottomlands and are generally used for hay and pasture. Drainage problems in these areas are usually complex. In many areas, there are old channels filled with gravel through which ground water flows creating a high water table. Also, seeps (springs) occur in some fields and can create a depression after installation of drainage. The occurence of sink areas together with severe after-drainage cracking of very fine textured soils necessitates additional land smoothing and leveling. Where wet areas affect several landowners, group drainage facilities are necessary to secure adequate outlets.

Almost 30 percent of the cropland soils with a wetness problem have been drained to a degree suitable for the crop grown. Drainage practices installed on these lands through 1966 are shown in table 306.

Table 306 - Drainage Practices Applied to Cropland
Subregion 7, 1966

Practices	Units	Oregon	Washington	Total
Conduits & Ditches	Miles	255	351	606
Structures	No.	115	263	378

Source: USDA, Soil Conservation Service Data

Erosion and Sedimentation

Water and wind erosion is widespread and often devistating in this subregion. Erosion and deposition both cause heavy damages to crops and property. An estimated 2 million acres of cropland in this subregion have an erosion potential (table 307). About 864,000 acres of cropland have a present erosion problem.

Table 307 - Cropland Areas with an Erosion Potential
Subregion 7, 1966

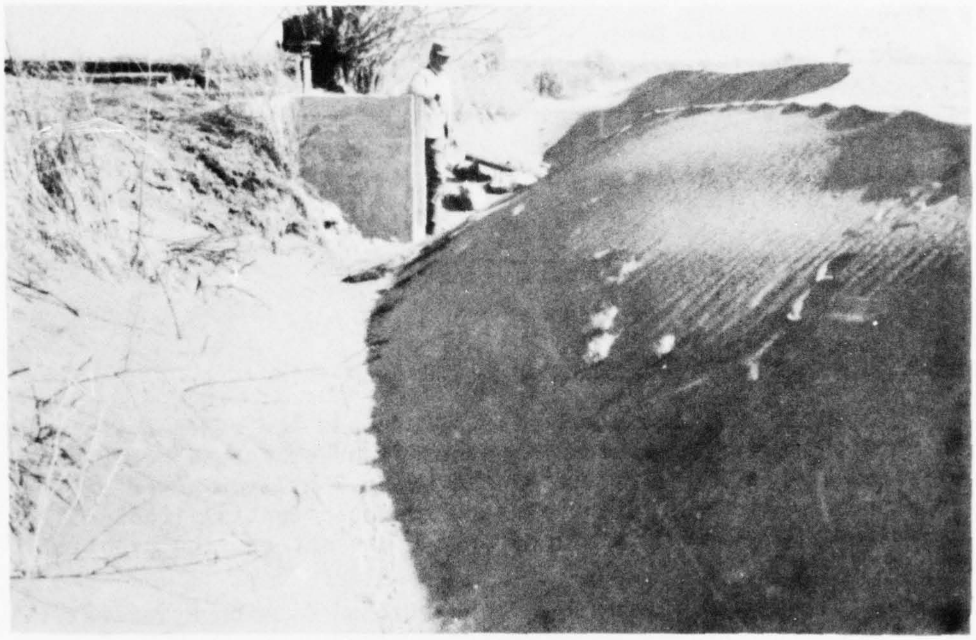
Capability Class	Oregon	Washington	Total
	-----	1000 Acres	-----
II	23	70	93
III	452	287	739
IV	1,024	175	1,199
Total	1,499	532	2,031

Source: Soil Conservation Service, C-NPRBS Data

In the areas with less than 10 inches of precipitation annually, the major problem is wind erosion where moderately coarse to coarse textured soils are disturbed or left unprotected. Wind erosion is damaging to crops, soil, soil structural development and causes sediment encroachment on roads, canals and other cultural structures.

Where water can be developed for irrigation of such land, growing crops and additional water supply reduce this particular problem.

Many of the creeks in this basin have a gradient of 30 to 50 feet per mile, which is quite erosive under flood conditions. Consequently, some have entrenched channels from 10 to 30 feet deep. This situation increases land destruction



Soil blown from field covers road and fills irrigation canal near Hermiston, Oregon. (SCS 0-1539-5)

by bank cutting and caving. Such channels also have the effect of prematurely lowering the water table in the narrow valleys in the spring to the detriment of the crops where water shortage is already a problem.

Scour, gully and rill or sheet erosion resulting from overflowing waters can cause serious damage to fields unprotected by vegetation. However, it is more frequent on cultivated lands and is most troublesome in wheat-fallow areas. In general, water erosion problems on arable lands occur over all the basin.

The overall rate of sediment production in the basin ranges from low to moderate (figure 44). Available estimates of the unit rate of sediment production indicate that the annual rate is from 0.02 to 0.1 acre-feet per square mile for all parts of the basin except that portion of Gilliam County south of Rock Creek. Here the annual sediment production is estimated to be from 0.2 to 0.5 acre-feet per square mile. The basinwide sediment production from cropland is 4,145 acre-feet annually, mostly from localized critical areas.

A post and stick fence is constructed to reduce wind erosion of soil and wind damage to plants. (SCS W-2985-6)

Heavy loads of sediment are deposited on the main highway in areas from the gorge below Dayville to above Monument, necessitating cleaning nearly every year. Roads and drainage ditches in other portions of the basin are also subject to localized sediment damage.

The cost of removing sediment deposited on roads and road ditches makes the monetary loss easier to identify. Other sediment damages, however, are not inconsequential. The few estimates of pond sedimentation now available indicate that these structures usually experience an average annual capacity loss of from 0.5 to 2.5 percent with the lowest losses for ponds in range areas and higher losses for those in wheat-fallow areas. Other losses are reduced capacity of streams, reduction of water quality, and damages to the environment.

Almost 1.2 million acres of cropland with an erosion potential have been adequately protected. Practices being used to control erosicn are shown in table 308.

Table 308 - Erosion Control Practices Applied on Cropland
Subregion 7, 1966

Practice	Units	Oregon	Washington	Total
Grade Stabilization Structures	No.	33	49	82
Diversions and Terraces	Miles	643	223	866
Ditch Bank Seeding	Miles	22	16	38
Field Windbreak	Miles	210	15	225
Crop Residue Use	1000 Acs.	409	331	740
Stubble Mulch	1000 Acs.	355	215	570
Grassed Waterway	Acres	28	1	29
Stripcropping	1000 Acs.	150	6	156
Conservation Cropping System	1000 Acs.	325	603	928
Pasture and Hayland Planting	1000 Acs.	106	54	160

Source: USDA, Soil Conservation Service Data

Rill erosion causes production loss, requires additional tillage, and creates deposition problems downstream. Fifty-eight tons of soil per acre was lost from this field. (SCS 0-1085-12)

A number of practices have been used to control erosion on dry cropland. These include chiseling and subsoiling, diversions (terraces), stripcropping, stubble mulching, and changing cropland to grassland. Within this subregion, there have been 866 miles of diversion terraces constructed, over 88,000 acres subsoiled, 156,000 acres stripcropped, 570,000 acres under a stubble mulch program, and over 15,000 acres converted back to grass. Most of this work has been done in the Umatilla and John Day Basins.

Flooding

In this subregion, over 86,000 acres of cropland are subject to flooding. Floods result primarily from snowmelt accompanied by rain, or from late spring and summer convection storms. The most common flooding is caused by runoff from winter and early spring snowmelt, combined with rain. The most damaging floods usually occur over a broad area when the ground is frozen during the winter and early spring. These moderately severe floods occur on a 5-year frequency and generally originate in the mountains as the result of rainstorms of low intensity, wide areal extent and long duration. They are associated with warm south to southwest chinook winds which cause rapid melting of snow.

Moderately severe flooding from convection spring and summer storms is less frequent at any one point and covers a limited area, usually less than 20 square miles. They can be expected throughout the year, but are most frequent in the late spring and summer.

The very severe floods in the bottomlands can develop from either type storm and seem to have a frequency rate of about 20 years. Damage would be more widespread and severe if the land were not used primarily for perennial hay and pasture crops.

The problems resulting from floods range from erosion and sedimentation to losses of crops and property. Crop damage is especially heavy from floods that occur during the growing season. Considerable land is lost through streambank erosion. Over 11 percent of the streambank with an erosion problem is considered severe. Damage is usually most prevalent in the swifter portions of the streams, however, larger slower portions have also contributed to the total problem. Stream channel work is usually most beneficial when a complete unit of stream channel is improved in a single coordinated project rather than by piecemeal work of individual landowners. However, at the

present time, individual landowners are working on channels in an attempt to reduce damages. Table 309 shows their accomplishments through 1966.

Table 309 - Flood Protection Measures Applied in Cropland Areas, Subregion 7, 1966

Practice	Units	Oregon	Washington	Total
Stream Channel Improvements	Miles	286	52	338
Streambank Protection	Miles	41	8	49
Stream Channel Stabilization	Miles	3	1	4
Dikes and Levees	Miles	27	14	41

Source: USDA, Soil Conservation Service Data

Forest Land

Forests cover 8.3 million acres or 44 percent of the total land area in the subregion. About 72 percent is in public and 28 percent in private ownership. Of this total, 78 percent is commercial forest land and 22 percent is noncommercial.

This commercial forest land currently supports nearly 62 billion board feet of merchantable timber, 84 percent on public land and 16 percent on private. It furnishes the raw material for an industry that accounts for 60 percent of the subregion's manufacturing employment. The 1964 timber harvest exceeded one billion board feet. In addition, the forest land, including nearly a million acres of juniper-grasslands, is some of the better grazing land in the subregion.

Although only 44 percent of the subregion is forested, over 85 percent, or 9.5 million acre-feet of the surface runoff originates here. Ninety-two percent of the urban population depends on these watersheds for much of their domestic water. Irrigation supplies, amounting to almost two million acre-feet annually, are produced essentially on these same areas.

The forest lands of the subregion are generally in a good condition, providing high quality water with extremely low over-all sediment yields. Average sediment production is slightly over 500 acre-feet per year, representing less than 10 percent of the total sediment produced from all lands in the subregion (table 310).

Table 310 - Present Sediment Yield, Forest Land, Subregion 7

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield Acre-feet Per Square Mile	Annual Sediment Yield Total Acre-feet	Percent
Very low	6,876.8	83	0.02 - 0.1	215	42
Low	1,160.3	14	0.1 - 0.2	181	36
Medium	280.3	3	0.2 - 0.5	88	17
High	--	--	0.5 - 1.5	--	--
Very high	10.9	--	1.5 - 4.0	25	5
Total	8,328.3	100		509	100

Source: Derived from figures 43 and 44.

More than 80 percent of the forest land is in the very low category with sediment the result of natural erosion. The remaining 20 percent is distributed among the more critical areas, where intensive land use has added sediment to the base load. It is on these critical areas that watershed rehabilitation work is being undertaken. Most of the current protection measures are aimed at maintaining the excellent condition of water supplies from the forested areas.

Watershed Protection

The general silvicultural method used is to mark individual trees or small groups for harvest. The sawlogs are removed with crawler tractors, although mobile cable yarders, operating from roads are used to harvest occasional small clear-cut settings in dense even-aged lodgepole and fir stands. On most lands, tractor trails and temporary roads are cross-drained and seeded to grass and legumes to prevent surface erosion and spread runoff. Logging debris is removed from streams and major draws to prevent debris washouts that cause damage to fish habitat and downstream improvements.

Most mainline roads are gravel surfaced with permanent culverts. Where necessary, excavated material is end-hauled to prevent wasting into live streams. Exposed cutbank and fill slopes are seeded to grass where slopes could be eroded and silt deposited in streams.

Reforestation measures include both planting and spot

seeding. Advance reproduction in the partial cut areas is protected from timber falling and yarding by on-the-ground administrative controls. The harvest activities and protection requirements are summarized in table 311.

Table 311 - Average Annual Timber Harvest Activity, Subregion 7

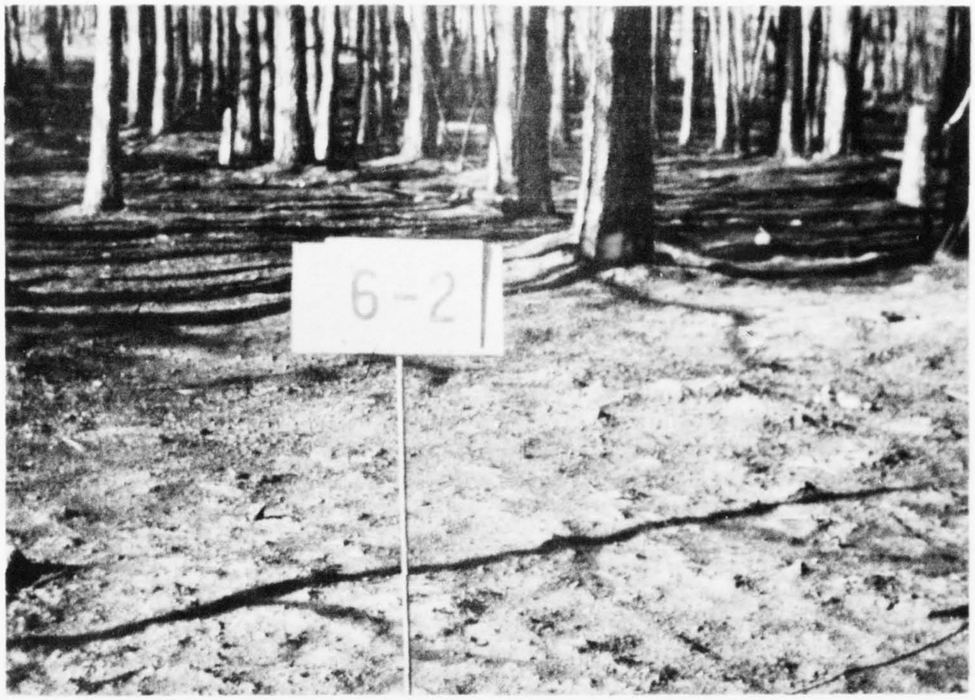
	Unit	Public	Private	Total
Harvest Area	Acres	47,000	30,000	77,000
Area Reforested 1/	Acres	5,000	3,000	8,000
Slash Disposal Area	Acres	23,000	6,000	29,000
Disturbed Area Treated 2/	Acres	7,000	--	7,000
Harvest Road Required	Miles	280	180	460
Harvest Road Treated 3/	Miles	220	--	220

1/ Includes planting, seeding and site preparation. Balance adequately stocked or requires no regeneration work.
2/ Includes seeding, mulching, debris removal and cross-draining skid roads and logging areas.
3/ Cut and fill stabilization only.

Watershed Rehabilitation

About 17 percent of the forest land produces almost 60 percent of the total sediment from forest areas. It amounts to an annual average of 295 acre-feet (table 310). Most of this sediment results from water movement down abandoned roads, across logged over areas and over-grazed forest range. Until recently, watershed protection measures were either inadequate or lacking altogether. Problem watersheds, particularly those in public ownership, are rehabilitated as funds permit.

Such work on public forest areas includes land treatment on over 6,000 acres annually. Nearly 600 miles of existing and abandoned roads and 50 miles of stream are also treated each year. Typical land treatment is the seeding following an extensive forest fire on the Umatilla Indian Reservation in the northeast corner of the subregion. The following pictures indicate the rehabilitation afforded by this treatment. Reservoir shoreline protection measures have been applied on National Forest lands in connection with the Bureau of Reclamation's Deschutes Project. In the past two years they have included the removal of snags on 813 acres of flooded area and the seeding of 264 acres of shoreline to reduce erosion by wave action. Not



Forest cover destroyed by fire in August 1961 and seeded to grass and forbs the following October. (Bureau of Indian Affairs)

included in this work is water fowl habitat improvement work conducted by state game agencies. (table 312).

Table 312 - Average Annual Accomplishment, Watershed Rehabilitation Practices on Public Forest Land, Subregion 7

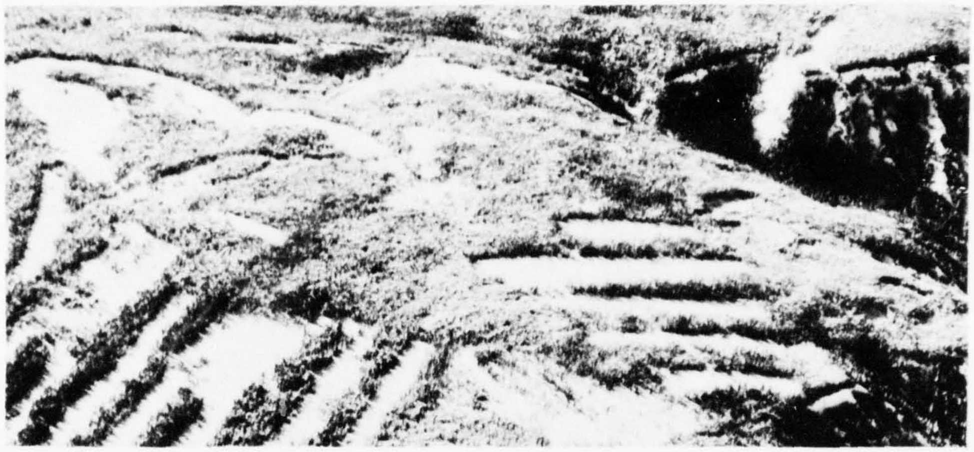
Practice	Unit	National Forest 1/	BLM	Indian Lands	State Lands 2/
Sheet Erosion Control	Ac.	2,675	--	3,000	--
Gully Stabilization	Mi.	40	--	--	--
Stream Clearance & Stabilization	Mi.	30	1	1	--
Existing Road & Trail Rehabilitation 3/	Mi.	525	3	10	--
Reservoir Protection	Ac.	540	--	--	--

1/ Average of period 1964-6.
2/ Minor Ownership
3/ Includes abandoned roads.
Source: Data furnished by agency as listed.

Most rehabilitation on the private forest lands is done in connection with the Agricultural Conservation Program and the Soil Conservation Service forestry program of the U. S. Department of Agriculture. In addition, in 1967, the 11,000 acre watershed fire of The Dalles received complete rehabilitation with substantial funding aid provided under Section 216 of the Flood Control Act of 1950.

Water Yield Improvement

Water yield improvement in the subregion is still on an experimental basis and done principally on National Forest areas. Canopy management for water yield on the Umatilla National Forest is shown in the following photograph. The long narrow clear-cuts accumulate deeper snowpacks which, in turn, quite often drastically changes the flow pattern of streams by decreasing peak flood flows and increasing minimum summer flows.



Timber harvest areas designed to increase snow accumulation and reduce snowpack melt. (Forest Service)

Rangeland

Rangeland in Subregion 7 amounts to 6.4 million acres, 34 percent of the total land area (table 301). About 4.8 million acres or 75 percent of all rangeland is privately owned. The public range covers 1.6 million acres of which 1.4 million acres is Federally owned. Rangeland classes and ownership are discussed in Appendix IV, Land and Mineral Resources.

During early livestock operations on the range, national forage was used at a rate far in excess of its grazing capacity with little consideration of long term range condition. Additional range damage resulted from improper location and methods of road construction, and range fires. By 1930 grazing land was generally in a depleted condition from which it has only recently begun to recover. Excessive grazing use had been reduced on an estimated 2.1 million acres by 1966 (33 percent of the total range), but 45 percent of the range remained in poor condition with deficient vegetative cover and considerable accelerated erosion. Present rangeland condition and capacity is shown on table 313. About 52 percent of the range has grass cover, 37 percent sagebrush, and 11 percent brush and shrubs. The estimated average grazing capacity of the private range is 6 acres per animal unit month compared to 10 acres per animal unit month on the public range. This subregion has an estimated annual grazing capacity of 955,400 animal unit months or 13 percent of the regional total.

Table 313 - Rangeland Condition and Capacity, Subregion 7, 1966

Range Type and Condition	Ownership					
	Public		Private		Total	
	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)
Grassland						
Good	--	--	474.1	182.4	474.1	182.4
Fair	2.5	.4	1,068.9	178.2	1,071.4	178.6
Poor	332.0	27.7	1,199.7	99.9	1,531.7	127.6
Seedings 1/	150.0	57.7	82.8	31.8	232.8	89.5
Total	484.5	85.8	2,825.5	492.3	3,310.0	578.1
Sagebrush						
Good	1.0	.3	394.5	98.6	395.5	98.9
Fair	7.2	.9	900.7	112.6	907.9	113.5
Poor	917.0	61.1	117.4	7.8	1,034.4	68.9
Total	925.2	62.3	1,412.6	219.0	2,337.8	281.3
Other Brush						
Good	1.0	.3	124.2	41.4	125.2	41.7
Fair	4.5	.7	265.3	37.9	269.8	38.6
Poor	149.5	7.4	165.8	8.3	315.3	15.7
Total	155.0	8.4	555.3	87.6	710.3	96.0
Total						
Good 2/	152.0	58.3	1,075.6	354.2	1,227.6	412.5
Fair	14.2	2.0	2,234.9	328.7	2,249.1	330.7
Poor	1,398.5	96.2	1,482.9	116.0	2,881.4	212.2
Grand Total	1,564.7	156.5	4,793.4	798.9	6,358.1	955.4
Percent Distribution	24.6	16.4	75.4	83.6	100.0	100.0
Average AC/AUM	10.0		6.0		6.7	

1/ Includes all seeded range. In Appendix IV this was combined with good condition grassland.
2/ Includes seeded range.
Source: Rangeland narrative, C-NP Appendix IV, Subregion 7. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

Overgrazing has destroyed the protective vegetative cover and soil mantle. Water which now falls on bare soil quickly flows over the surface carrying the soil to lower elevations. (Forest Service)

Major agricultural uses of water are for production of forage, grain and livestock. With optimum range conditions and an increased range forage crop, an estimated 5,000 acre-feet of water would be consumed annually by livestock, about twice the amount presently required. Soil conditions conducive to maximum yields of usable water have deteriorated, causing decreased infiltration rates and increased runoff. In areas having less than 10 inches of precipitation, wind erosion is a major problem on course textured soils which are disturbed or left unprotected. This is particularly true of the low lying range near the Columbia River. Most of the rangeland in the subregion is subject to varying degrees of water erosion. The average annual rangeland sediment yield is 1,250 acre-feet (table 314), or 21 percent of the subregion's total. About 718 acre-feet (57 percent of the range yield) comes from 865,000 acres or 14 percent of the range in the "Medium", "High", and "Very High" sediment yield categories. This includes 680,000 acres of grasslands interspersed with cropland areas on low lands of the Columbia Plateau. It also includes

Table 314 - Sediment Yield from Rangeland, Subregion 7, 1966

Sediment Yield 1/ Categories	Grassland	Sagebrush & Shrubs	Total	Percent
		Rangeland Acreage (1,000 Acres)		
Very Low	2,608.6	2,749.8	5,358.4	84
Low	20.5	113.9	134.4	2
Medium	549.1	154.9	704.0	11
High	131.8	--	131.8	2
Very High	--	29.5	29.5	1
Total	3,310.0	3,048.1	6,358.1	100
		Annual Sediment Yield (Acre Feet)		
Very Low	245	257	502	40
Low	5	27	32	3
Medium	300	85	385	31
High	206	--	206	16
Very High	--	127	127	10
Total	756	496	1,252	100

1/ Very Low through Very High cagetories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 per acre feet respectively.
Source: Derived from figures 43 and 44.

185,000 acres of sage and other brush in two general locations; (1) along the John Day River near its junction with the Columbia River; and (2) in the Prineville area of the Ochoco Mountain foothills. Flooding is not a particularly serious range problem but range use and management practices have a significant effect on flood and sediment problems of downstream cropland and developed areas.

Measures and Practices for Watershed Protection

Rangeland measures and practices accomplished through 1965 for watershed protection and improvement (table 315) have multiple objectives and benefits. Many of them also serve management objectives other than improving the watershed. Cover improvement and soil stabilization practices have been applied on about 700,000 acres or rangeland. An estimated 232,800 acres have been revegetated, mainly by grass seeding, brush was controlled on 224,600 acres, and 213,800 acres of weed control were reported. About 50 percent of these efforts were for watershed improvement; the remainder for improved forage production.

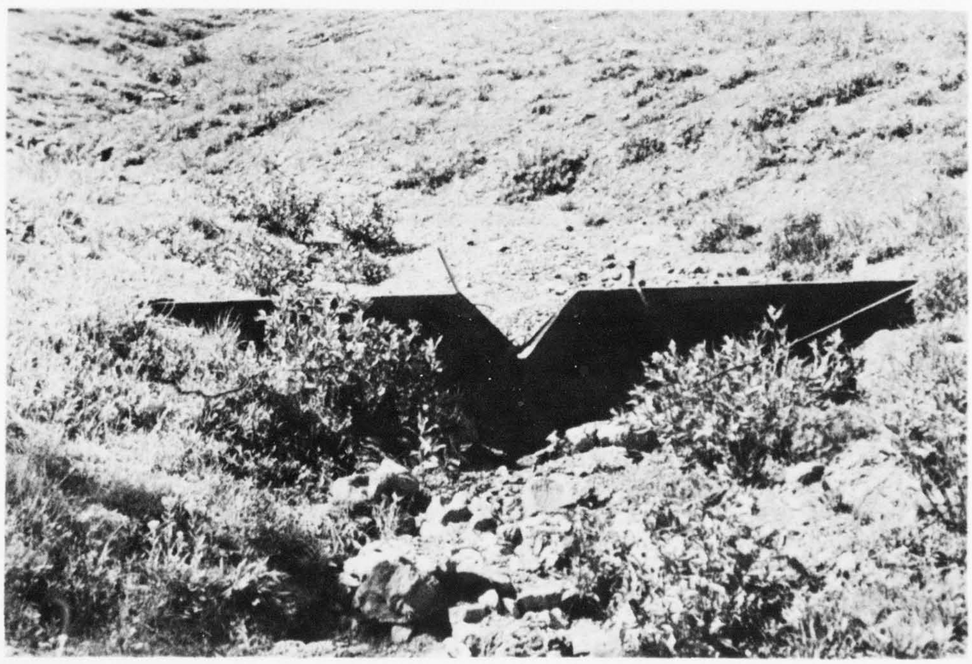
Table 315 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Up to 1966, Subregion 7 1/

Measures & Practices	Units	Land Ownership Public 3/	Private	Total	Watershed Purposes 2/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	150,000	82,800	232,800	-	x	x	x
Brush Control	Acres	108,500	116,100	224,600	-	-	x	-
Weed Control	Acres	52,600	161,200	213,800	-	x	x	x
Conversion of tree cover to grass	Acres	4,900	15,100	20,000	-	x	x	x
Contouring, Pitting, Furrowing	Acres	100	400	500	-	x	x	-
Stream & Bank Stabilization	Acres	50	150	200	x	x	x	x
Waterspreading	Acres	60	1,900	1,960	x	x	x	x
Irrigation	Acres	1,200	3,800	5,000	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	3,200	9,700	12,900	-	x	x	-
Reducing Excessive Grazing Use	Acres	280,100	1,858,100	2,138,200	-	x	x	-
Livestock & Game Water Facilities	Number	1,000	4,300	5,300	-	x	x	-
Road Stabilization	Miles	500	NA 4/	NA 4/	x	x	x	-
Stream Clearance	Miles	4	12	16	x	x	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	800	2,700	3,500	x	x	x	x
	Acre Ft.	600	5,400	6,000	x	x	x	x
Detentions	Number	75	225	300	x	x	x	-
	Cu. Yds.	38,800	118,800	157,600	x	x	x	-
Check Dams (Gully Plugs)	Number	1,900	5,900	7,800	-	-	x	-
	Cu. Yds.	7,400	22,600	30,000	-	-	x	-
Dikes	Lin. Ft.	10,400	32,000	42,400	x	-	x	x
Diversions	Number	20	160	180	x	x	x	x
	Cu. Yds.	27,600	264,900	292,500	x	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.
4/ Not available.

The initiation of grazing management systems has allowed sufficient rest periods for natural revegetation of range forage cover, and grazing use has been adjusted to the range grazing capacity on an estimated 2.1 million acres. Development of 5,300 livestock and game watering facilities, coupled with the construction of about 12,900 miles of livestock control fences, has helped provide a wider and more systematic range livestock use. Watershed protection measures have been incorporated in the maintenance and improvement of about 500 miles of public access roads and trails as well as a number of private roads. Stream clearance was reported along 16 miles of waterways.

Water control structures (developed for erosion control, debris control and reduced flows and conservation of early season runoff) included about 3,500 ponds and small reservoirs with a storage capacity of 6,000 acre-feet, 480 detention or diversion dams, 7,800 check dams, and 8 miles of dikes.



A number of check dams have been constructed to prevent channel cutting while protective vegetative cover is being re-established on eroding slopes. Note sediment deposit being held behind this structure. (Forest Service)

Other Land

Other land covers 565,200 acres, which is three percent of the subregional land area. It includes 36,400 acres of small water bodies in streams, lakes, and reservoirs; 101,900 acres in roads and railroads; 80,900 acres in farmsteads, urban, industrial and miscellaneous areas; and 346,000 acres of barren land.

Some forty urban areas have indicated deficiency in water supply. The need varies and includes additional water, better quality water, or a more economical source.

Surface drainage is not generally an urban problem in this subregion, although there are isolated problems of surface drainage for mosquito control. A few areas have problems with sewage disposal by septic tanks and drain fields because of adverse soil conditions. There are a few minor problem areas of drainage involving roads.

Neither wind nor water erosion is a big problem in urban areas. This is mostly true with barren areas, although there are a few areas with active dunes. Most of the barren lands are rock outcrops or talus slopes and are subject only to geologic erosion.

Over 2,300 acres of urban areas are subject to flooding and sedimentation. Damage to roads from flood erosion is extensive and the cost of removing silt and debris from road ditches, culverts, road beds, etc. is in the thousands of dollars.

FUTURE NEEDS

Population is expected to increase from 198,700 in 1960 to 404,400 by 2020. Much of the total population increase will be associated with an expanding agricultural industry although actual farm population is projected to decrease from 28,500 to 12,000 (58 percent) during this same period.

Projected change in cover and land use is shown on table 316. Although farm population will decline, the expanding agricultural industry will require an anticipated 14 percent increase in cropland acreage, with significant irrigation development. The "other land" acreage is expected to increase by 30 precent, primarily for urban and recreational purposes. These increases will occur mostly from conversion of rangeland and noncommercial forest areas adjacent to agricultural and urban areas.

Table 316 - Projected Change in Cover and Land Use
Subregion 7

	1966	1980	2000	2020
	1000 Acres			
Cropland	3,570.6	3,729.0	3,735.0	3,805.0
Forest Land	8,328.3	8,273.5	8,205.8	8,118.0
Rangeland	6,358.1	6,176.0	6,162.0	6,106.0
Other Land	565.2	613.1	675.0	732.6
Total	18,822.2	18,791.6	18,777.8	18,761.6

Source: C-NP, Economic Base and Projections, Appendix VI

Cropland

At the present time, 40,500 acres of cropland have a drainage problem, over 86,000 acres are subject to frequent flooding, 864,000 acres have an erosion problem of varying degrees, and over 240,000 acres of irrigated land do not have a full-season irrigation water supply. A large portion of these problems must be solved if natural resources are to meet the demand for food and fiber and clean water. Cropland areas will also increase. The probable trends in cropland, both irrigated and dry-farmed, are shown in table 317.

Table 317 -Projected Trends in Dry and Irrigated
Cropland, Subregion 7

Cropland	1966	1980	2000	2020
	1000 Acres			
Dry Farmed	3,046.2	2,895.0	2,817.0	2,619.0
Irrigated 1/	525.4	834.0	918.0	1,186.0
Total	3,571.6	3,729.0	3,735.0	3,805.0

1/ Approximately 97 percent of projection in Appendix IX, Irrigation.
Source: C-NPRBS Projections.

Water Conservation

The need for food and fiber by 2020 will require the irrigated acreage to increase over 125 percent. Reasons for this prediction include: (1) The climate is sufficiently mild especially under 3,000 feet, so that a variety of crops can be grown; (2) there are ample irrigable soils onto which irrigation can be applied; (3) storage resources of two river basins, Umatilla and

John Day, have not been developed; (4) transportation by water, rail, and highway is available to insure access to markets. Although there are a number of good sites, there is only one major dam in the Umatilla System and none in the John Day. In addition, Columbia River water can also be used to develop lower areas.

The increase in irrigated cropland and supplemental water for presently irrigated cropland will increase the demand for agricultural water supplies by over 100 percent despite an increase in efficiency of water use. Changes predicted in method of applying water to land are presented in table 318.

Table 318 - Projected Cumulative Trend in the Method of Irrigation on Cropland, Subregion 7

Item	1966	1980	2000	2020
	1000 Acres			
Sprinkler Systems	124	340	600	948
Flood Systems	401	380	318	238
Total Irrigated Area	525	720	918	1,186

Source: Soil Conservation Service, C-NPRBS Projections

Drainage

Over 57,000 acres of cropland have a wetness problem at present and drainage problems exist on 40,500 acres of this area. The addition of over 2 million acre-feet of irrigation water to cropland areas in the subregion is expected to increase cropland acreage with a wetness problem by almost 50 percent to 85,800 acres by 2020. Over 65 percent of this acreage will need drainage by 2020 in order to meet food and fiber needs (table 319).

Table 319 - Cumulative Cropland Areas Needing Drainage Subregion 7

Item	1966	1980	2000	2020
	1000 Acres			
Wet Areas	57.8	63.4	74.6	85.8
Projected Accomplishments	17.3	25.4	41.5	57.8
Remaining	40.5	38.0	33.1	28.0

Source: Soil Conservation Service, C-NPRBS Projections

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COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
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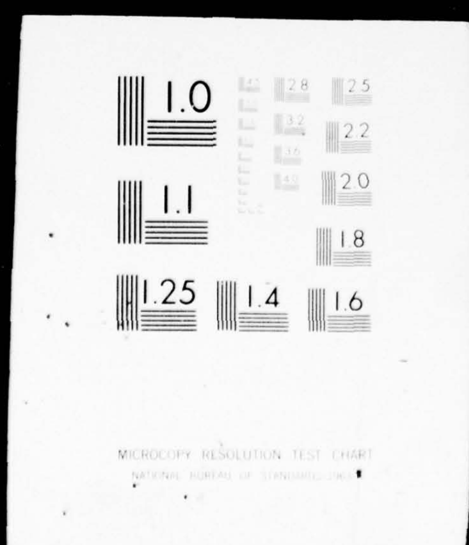


Erosion and Sedimentation

Over 2 million acres of cropland now have an erosion potential and 864,000 acres of this land have present erosion problems. Shifts in land use and cropping patterns are expected to increase the acreage of erosion potential by approximately 10 percent or to 2.2 million acres by 2020. In the next 50 years considerable effort will be required to reduce erosion and sedimentation damage by improved land treatment and management techniques (table 320).

Table 320 - Cumulative Cropland Areas Needing Erosion Control, Subregion 7

Item	1966	1980	2000	2020
	------------1000 Acres-------------			
Erosion Potential	2,031	2,086	2,159	2,234
Projected Accomplishments	1,167	1,366	1,790	2,216
Remaining Problem	864	720	369	18

Source: Soil Conservation Service, C-NPRBS Projections

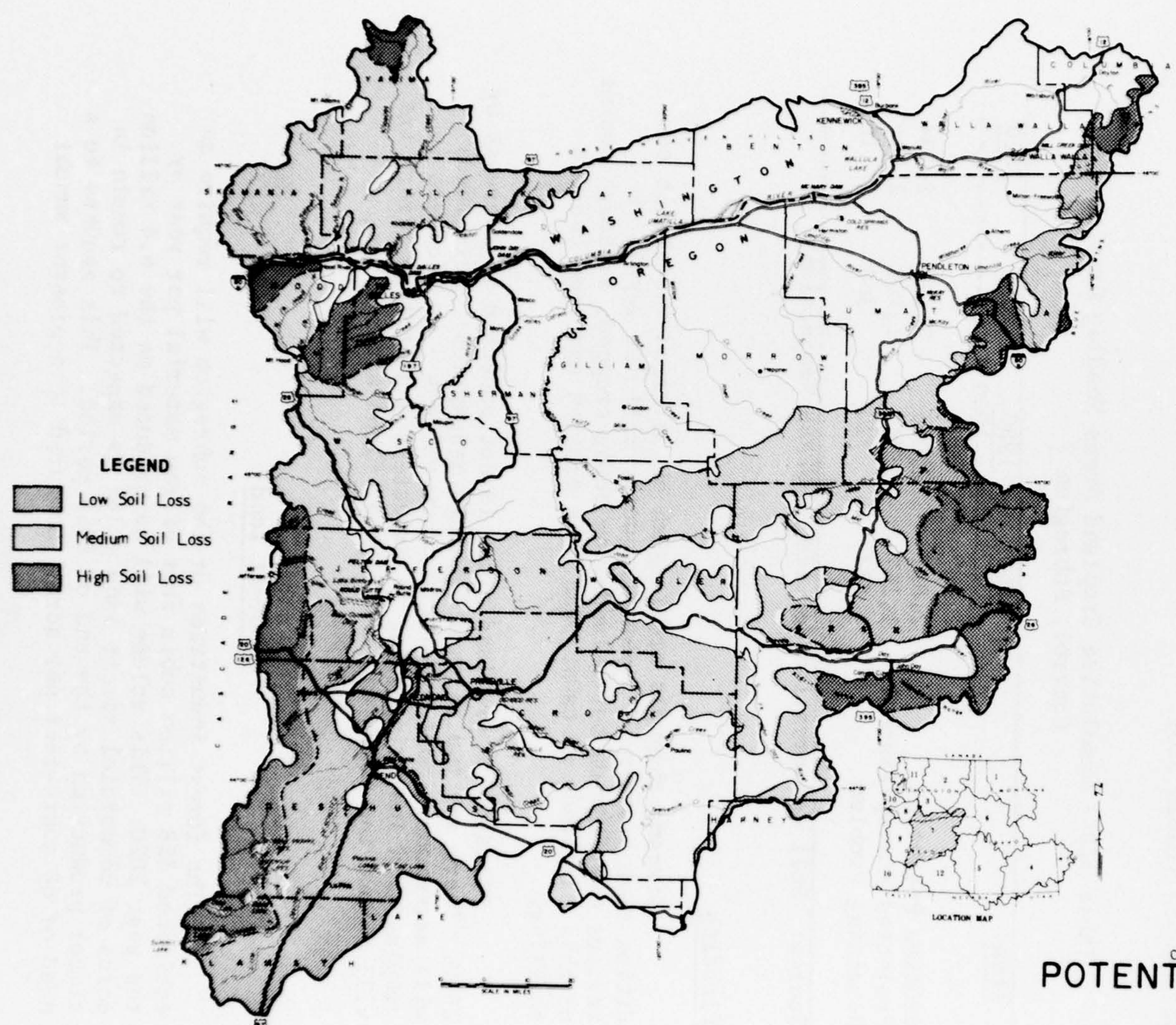
Flooding

Streams channels are in such an enlarged and stable condition that a storm of 5-year frequency will not result in serious overflow on bottomlands now being cropped, although storms of this magnitude do cause some bank erosion and some bedload shifting.

Flooding in cropland areas is not expected to increase by 2020. There are two reasons for this assumption: Streambeds will accommodate most predicted storm volumes - no increase in croplands in low lying areas is expected; and storage reservoirs will reduce the depth and duration of flood waters.

Forest Land

The forest industries of the subregion will require an estimated 358 million cubic feet of raw material per year by the year 2020. This volume will be produced on the 6.4 million acres of commercial forest land which is expected to remain in timber production by the end of this period. This amounts to a need of 60 cubic-feet per acre. Compared to a present annual



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

POTENTIAL EROSION HAZARD FOREST LAND

MID COLUMBIA, SUBREGION 7

1968

FIGURE 45

industrial consumptive rate of 39 cubic-feet per acre of commercial forest land, it is apparent that timber yield improvement will be necessary. In this subregion, faster restocking, fertilization, thinning and release are among the management tools needed.

Potential erosion hazard and sediment yields have been determined for the forest lands of the subregion. They are shown on figure 45 and summarized on table 321. This data represents potential yields prior to treatment or protection and could exceed present levels by over 10 times.

Table 321 - Potential Sediment Yield without Protective Measures, Forest Land, Subregion 7

Soil Loss Category	Acres (1,000)	Percent	Acre-feet per Square Mile per Year	Total Acre-feet per Year
Low	1,753.0	21	Less than 0.2	274
Medium	4,898.5	59	0.2 - 1.5	1,530
High	1,676.8	20	More than 1.5	3,930
Total	8,328.3	100		5,734

Source: Soil Survey Data & Interpretations, U.S. Forest Service, Region 6

Watershed Protection

Acceleration in timber harvest and road construction programs are required to meet the subregion's increased wood fiber demands. The rate at which these programs are expected to be implemented is shown in table 322. Road construction will continue at this rate until the ultimate system is finished. Also included in table 322 is the forest acreage that will be disturbed by these operations.

Table 322 - Projected Cumulative Timber Harvest Activity, Forest Land, Subregion 7 1/

	Unit	1980	2000	2020
Timber Harvest Area	Acres	1,163,000	2,723,000	4,126,000
Road Construction	Miles	7,000	16,400	24,700
Ground Disturbance 2/	Acres	245,000	573,000	866,000

1/ Based on the 1965 level of timber requirements.
2/ Includes both harvest area requiring protection, and road mileage, converted to acres, requiring cut and fill treatment.

As indicated in table 322, the 2020 timber harvest will exceed 4 million acres and road construction and logging will damage the protective cover on 866,000 acres. These areas are potentially heavy sediment producers unless adequate revegetation and protective measures are introduced.

Watershed Rehabilitation

Seventeen percent or 1.4 million acres of forest land in the low through very high sediment yield categories (table 310), still require treatment to control erosion. Those areas contributing most to pollution such as tracts of old logging, overgrazed areas, abandoned roads, and damaged stream channels will require the most intensive treatment.

Water Yield Improvement

One of the most significant potentials of the subregion's forest lands is supplying abundant clean water. Presently nearly 9.5 million acre-feet, representing 85 percent of the subregion's annual runoff, originates in forest areas.

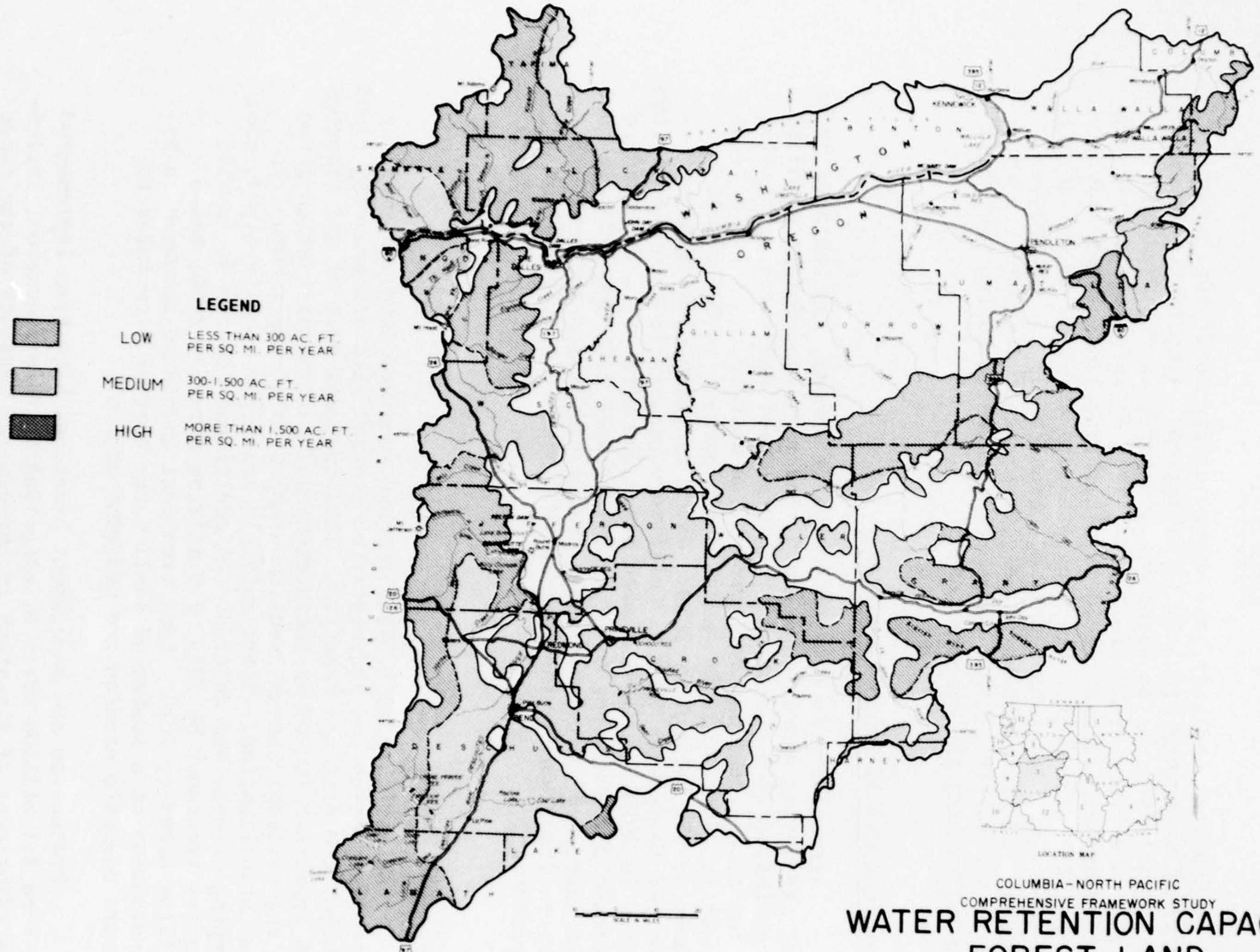
The Water Retention Capacity Map (figure 46) and table 323 indicate the ground-water storage capacity of the forest soils in the subregion. The area in the "medium" class alone has a storage capacity of over 8 million acre-feet, almost equal to the subregion's annual runoff.

Water yield improvement programs on these soils would do much to improve stream-flow characteristics during both periods of peak and low flows.

Table 323 - Water Retention Capacity, Forest Soils
Subregion 7

Retention Class	Acres (1,000)	Percent	Acre-feet per Square Mile	Total Acre-feet
Low	2,332.2	28	Less than 300	1,100,000
Medium	5,996.1	72	300 - 1,500	8,400,000
High	--	--	More than 1,500	--
Total	8,328.3	100		9,500,000

Source: Soil Survey Data & Intrepretations, USDA, Forest Service, Region 6.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER RETENTION CAPACITY
FOREST LAND

MID COLUMBIA, SUBREGION 7

1968

FIGURE 46

Rangeland

Erosion, sediment, and water quality constitute major rangeland watershed problems in Subregion 7. Sediment yields are particularly serious on about 865,000 acres in the "Medium," "High," and "Very High" yield categories shown on table 314. The average annual sediment yield from all rangelands is presently about 1,252 acre-feet. Flooding problems exist on 25,000 acres, and some 8,000 acres have drainage problems.1/ Watershed programs require measures to resolve present watershed problems and to adequately protect range resource while making projected changes in land and resource use.

Projected Use of Range Resources

Agriculture is a major source of income, particularly range beef production and dryland grain, and rangeland forage produces an estimated 11.9 percent of the total beef and sheep production of the area. Beef and veal production amounted to 151.4 million pounds in 1964. This is expected to increase to 388.2 million pounds or 156 percent by 2020. Sheep and lamb production is expected to decline from 8.7 million pounds in 1964 to 6.6 million pounds in 2020. (3) Although rangeland acreage is expected to decrease 252,000 acres or 4 percent between 1966 and 2020, it must meet increased demand for range forage production along with greater requirements for recreation use and wildlife habitat improvement.

Watershed Needs

An estimated 358,000 acres had received land treatment by 1966 for erosion and sedimentation control with accompanying flood control and drainage benefits. This includes most of the measures and practices for cover improvement and soil stabilization given in the "Present Status" section along with accomplishments in road stabilization. Where multiple practices were involved, overlapping acreage was deleted. An additional 982,000 acres will require treatment by 1980, 1.9 million acres by 2000, and 3.3 million acres by 2020. Land treatment should be accompanied by development of a number of small water control structures to assure adequate erosion and sediment control.

Protection and management practices have been implemented on some 2.1 million acres of rangeland in this subregion, including adjustment of livestock to the grazing capacity of the range and special fire control practices where required. Other measures

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1/ Soil Conservation Service, C-NPRBS data.

associated with improved livestock distribution and control were livestock and game water facility development and construction of livestock control fences. Similar practices should be extended to an additional 1.3 million acres by 1980, 2.2 million acres by 2000, and 2.4 million acres by 2020. More information is needed on the relative importance of big game and livestock competition for range forage and a proper balance determined. Special areas need to be set aside and developed as winter range for big game.

By 1966, an estimated 16 miles of rangeland streams had been improved by stream clearance, channel improvement, or efforts to improve water quality. An additional 16 miles need attention by 1980, 24 miles by 2000, and 85 miles by 2020. More consideration must be given to water quality standards and control relative to rangeland use and management. Deficient water quality areas must be identified and specific measures and practices determined to achieve the objectives of improved water quality in conjunction with other range management objectives.

An estimated 20 miles of bank stabilization work had been accomplished in rangeland areas by 1966. This includes the stream and bank stabilization acreage reported in the "Present Status" section with conversion to miles on the basis of 10 acres per mile. Future needs include an additional 110 miles of bank stabilization along streams and reservoirs by 1980, 290 miles by 2000, and 540 miles by 2020.

About 8 miles of dikes have been constructed on rangelands to provide flood control and prevent damage from sediment and debris. An additional 12 miles of dikes will be needed by 1980, 27 miles by 2000, and 39 miles by 2020.

Other Land

In urban areas, almost 2,300 acres are subject to frequent flooding. An estimated 40 urban areas need additional or new municipal and industrial water supplies. This contrast of too much and too little water is common to the subregion.

Practically all of the urban areas that have flood problems are adjacent to cropland areas that also have flood problems. These problems are discussed more completely under flooding in this appendix and in Appendix VII, Flood Control.

All of the urban areas have access to sources of water such as possible storage sites, streamflow, or ground water. The problem is in the communities' economic resources. A more complete

discussion of these problems can be found in Appendix XI, Municipal & Industrial Water Supply.

There will be additional watershed protection requirements on roads and highways, as well as on building sites. Drainage, cut and fill slope protection and flood control measures will be required in these areas.

Reservoir areas will be increased by about 60,000 acres by 2020 for water supplies and for regulating streamflows to reduce flood and debris damage. Total "other land" acreage will increase from 565,000 acres to 733,000 acres (about 30 percent) in the same period. This increase will primarily be for urban and recreational use.

MEANS TO SATISFY NEEDS

Needed watershed treatment to be accomplished by 2020 will require increased coordination of programs to meet the numerous and more intensive demands for land and water resources. The land measures and watershed protection for optimum safe use of all lands are discussed in this section in terms of structural and nonstructural programs. The means to accomplish watershed protection are discussed by individual items which are costed in 1969 dollars.

In this subregion, 158 watershed areas (128 in Oregon and 30 in Washington) comprise the basis for a conservation needs inventory. (4) This survey indicates that 57 require cooperative planning and land treatment. About 18 have a high potential for meeting needs that should be developed in the near future; 20 have potentials that should be provided for by the year 2000; and 29 require action by 2020. Table 324 shows the means for satisfying conservation needs by cooperative action within watershed areas.

Over 860,000 acres of cropland, 865,000 acres of range, and 340,000 acres of forested land are subject to serious erosion. About 86,000 acres of cropland, and 25,000 acres of rangeland are subject to flooding and sediment deposition.

Water, whether it is too much or too little, is a major concern in this subregion. Of the 158 conservation needs study areas, 15 percent show a deficit in agricultural domestic water and 17 percent indicate a shortage in livestock water. In addition, 26 percent of the areas show a need for supplemental

municipal and industrial water. Fifty-four percent need water for additional recreation, 67 percent for fish and wildlife, and 46 percent for water quality control.

Table 324 - Practices Required for Cooperative Conservation Development, Subregion 7

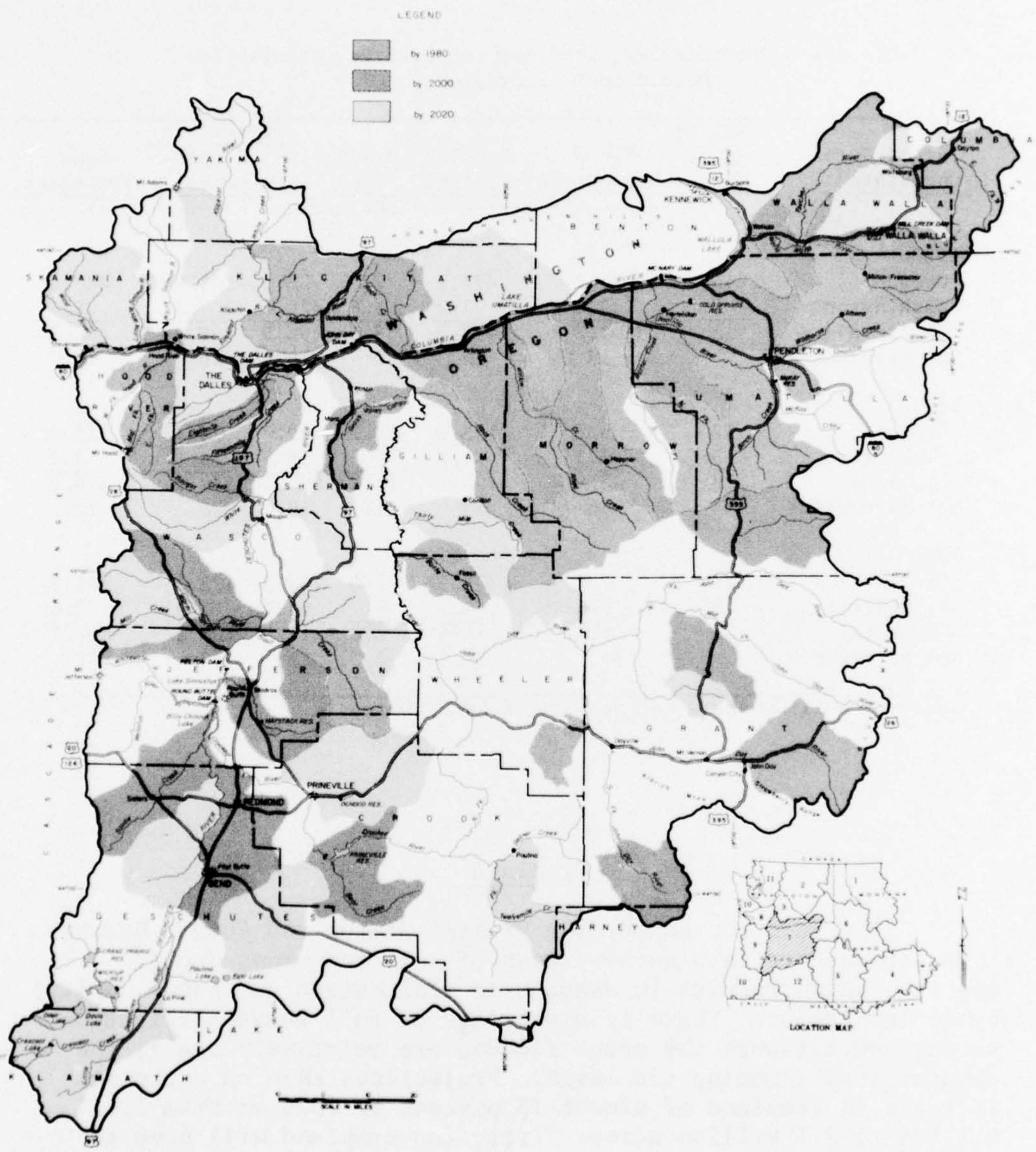
Target Date and State	No. of Water-sheds	Flood Protection	Erosion Control	Drain-age	Irrigation New	Irrigation Supple-mental	Land Treatment
		1000 Acres					
1980							
Oregon	15	26.2	471.5	7.1	58.5	101.9	480.0
Washington	3	5.0	2.2	1.5	410.0	7.5	8.7
Subtotal	18	31.2	473.7	8.6	468.5	109.4	488.7
No. Watersheds		14	15	9	16	16	17
2000							
Oregon	17	9.8	103.8	10.2	640.7	74.4	313.9
Washington	3	3.1	1.3	--	38.5	38.5	4.4
Subtotal	20	12.9	105.1	10.2	679.2	112.9	318.3
No. Watersheds		16	18	11	20	20	19
2020							
Oregon	21	7.6	475.5	2.0	147.3	122.3	483.1
Washington	8	0.5	3.1	--	63.7	3.9	3.6
Subtotal	29	8.1	478.6	2.0	211.0	126.2	486.7
No. Watersheds		15	29	7	29	29	22

Source: Soil Conservation Service, C-NPRBS Data.

Cropland

The sections concerning Present Status and Future Demands have shown there is a serious loss of soil and crops due to erosion, which results in damages to real estate and water quality by sedimentation. There is a shortage of full season irrigation water; and although the areas flooded are relatively small, the damages from flooding are large. Projections show an estimated increase in cropland of almost 15 percent by 2020 or from 3.6 million to 4.1 million acres. Irrigated cropland will need to expand by an estimated 125 percent, or from 525,000 to 1,186,000 acres, in the same period.

Assistance will be needed by land owners and users of the land in the direction and planning of group facilities and projects



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

MID COLUMBIA, SUBREGION 7

1968

FIGURE 47

to provide for storage, conveyance, and distribution of irrigation water to meet these increases. Group planning and installation of practices are needed for erosion control, drainage, and flood prevention.

Additional cropland is available from land presently not cultivated, but capable of more intensive use (table 325).

Table 325 - Land Areas Suitable for Crop Production
Subregion 7, 1966

Capability Classes	Oregon	Washington	Total	Percent
	-----------	1000 Acres	-----------	
I	7.0	13.0	20.0	1
II	343.0	212.8	555.8	10
III	1,277.0	696.2	1,974.3	35
IV	2,557.0	480.5	3,037.5	54
Total	4,184.0	1,402.5	5,586.5	100

Source: Soil Conservation Service, C-NPRBS Data

Water Conservation

Projections indicate that 9 percent of the potentially irrigable land will need to be irrigated by the year 2020. The three methods to meet the irrigation water needs of the area are: (1) Pumping water from the Columbia River; (2) storage reservoirs on the major tributaries such as the John Day, Walla Walla, Umatilla, and Deschutes Rivers; and (3) use of groundwater supplies.

Water from the Columbia River can be used to develop lower areas, but other sources are more economical for areas more remote from the river because of increases in elevation and pumping distance. An estimated increase of 2.6 million acre-feet is needed in farm delivery of irrigation water to meet the total requirements for water short areas, as well as the projected increase in new irrigated acres by the year 2020.

Reconnaissance surveys have been made on several potential storage sites on the various tributaries, but considerable more detailed studies are needed to determine the most feasible sites. Study is needed on the feasibility of recharging groundwater supplies for irrigation. A potential area for this type of storage is in the area of Walla Walla.

Irrigation by sprinkler irrigation systems is increasing and by 2020 almost 85 percent of the irrigated area will probably be under sprinklers.

Concrete lined irrigation ditch to prevent water losses in transporting water to the fields. (SCS 0-1109-4)

Of the additional 661,000 acres projected to be under irrigation by 2020, 96 percent (630,000 acres) is expected to require water supplied by reservoir storage. The remaining area could be supplied by groundwater and streamflow. Of the 630,000 acres irrigated from reservoir storage, 340,000 acres are expected to divert water which is derived from storage in the Columbia River System. The remaining 290,000 acres could have water supplied by storage in the upper watersheds. It is estimated that over 350,000 acre-feet of water will be available to new irrigated lands through more efficient use.

Increases in the irrigated area and shifts in the method of applying water will require more sophisticated irrigation practices. The rate at which these are projected to be applied is shown in table 326.

Table 326 - Cumulative Projected Practices for Irrigated Cropland, Subregion 7

Practice	Unit	1966	1980	2000	2020
Water Control Facilities	No.	23,219	21,300	47,600	63,400
Water Storage	No.	106	240	490	730
Irrigation Water Conveyance	Mi.	5,083	6,860	10,410	13,870
Irrigation Systems, Surface	No.	1,988	1,880	1,570	1,170
Irrigation Systems, Sprinkler	No.	1,806	4,826	11,146	17,726
Land Shaping	1000 Acs.	104	140	210	284
Irrigation Water Mgt.	1000 Acs.	113	420	820	1,220

Source: Soil Conservation Service, C-NPRBS Projections

Drainage

In the cropland areas, 57,800 acres have a wetness problem. Of these, 40,500 acres are wet enough to limit choice of crops and reduce yields. As noted in the Present Status Section, considerable work has been done on drainage. It has been estimated that drainage installations have already accomplished about 30 percent of the needed drainage. Table 319 shows cropland drainage problem areas and the projected increase for future years. The projections for future years are based on an expected increase of 28,000 acres of cropland having a wetness problem because of irrigation expansion. This table also shows that by 2020 drainage practices should alleviate drainage problems on about 56,000 acres. The drainage practices necessary to drain cropland areas at the projected rate are shown on table 327.

Table 327 - Cumulative Practices Required to Provide Needed Drainage, Subregion 7

Practice	Unit	1966	1980	2000	2020
Drainage Conduits & Ditches	Miles	606	890	1,450	2,020
Drainage Structures	No.	378	550	910	1,260

Source: Soil Conservation Service, C-NPRBS Projections.

Erosion and Sedimentation

Of the 3.6 million acres of cropland, over 2 million acres have been classified as having a potential erosion problem. Of these, over 860,000 acres presently have an active erosion problem. Table 320 shows the erosion potential and the rate at which these areas should be treated.

Erosion of cropland areas can be effectively controlled through agronomic, cultural, and structural measures. It is important to plan for the installation of practices and the management of vegetation and tillage operations by fields based on slope, texture, soil structure, and characteristics and erosion resistance of the crop to be grown.

The practices necessary to treat eroding areas and to maintain other areas in a stable condition are shown in table 328.

Table 328 - Required Erosion Control Practices
Subregion 7

Practice	Unit	1966	1980	2000	2020
Grade Stabilization Structures	No.	82	120	210	300
Diversions and Terraces	Mi.	866	2,350	4,320	6,290
Ditch Bank Seeding	Mi.	38	55	97	138
Field Windbreaks	Mi.	225	275	340	410
Crop Residue Use	1000 Acs.	740	860	1,020	1,180
Stubble Mulch	1000 Acs.	570	730	950	1,170
Grassed Waterway	Acres	29	260	580	890
Stripcropping	1000 Acs.	156	240	360	470
Conservation Cropping System	1000 Acs.	928	1,360	1,930	2,500
Pasture & Hayland Planting	1000 Acs.	160	210	270	330

Source: Soil Conservation Service, C-NPRBS Projections

Areas in Land Capability Class II on which grain is to be grown, stubble mulch is an essential practice to protect the soil. Subsoiling and minimum tillage improve the intake characteristics of most soils in the subregion. On Capability Class III, soils planted to grain, structural and vegetative measures as well as cultural practices are required. Diversions, waterways and stripcropping are needed to supplement stubble mulching,

Diversion terraces control erosion while removing excess runoff. (SCS 0-1440-1)

crop residue use, and minimum tillage. Most soils will have less erosion when a program of subsoiling every 4 to 5 years is used. The practice of deep furrow seeding on the contour is needed on some soils, and early fall seeding will provide winter cover for most years. Capability Class IV soils growing grain require more intense use of these same practices. In addition, more careful management is required and a more frequent rotation program with grass is essential.

Soils that are prone to erosion from the action of wind require similar practices regardless of capability class, although Class IV requires more intensive treatment than Class II. Protection from wind erosion is accomplished by reducing wind velocities at the surface of the field. Such practices as stubble mulching, cloddy tillage, wind stripcropping, wind breaks, and minimum tillage are some of the practices used.

Peas are close grown in rotation with small grain in some areas with over 16 inches of precipitation. The most important practice for erosion control is dry plowing, since all pea vines are usually removed during harvest and are not available for mulching. Dry plowing leaves the soil in cloddy condition to protect the soil. Fall seeded grain is seeded in a cloddy seed bed; for spring seeded grain, the fields are left cloddy all winter and are worked prior to seeding.

Grass and legumes protect the soil from erosion. For this reason, the only practices necessary for hay and pasture programs are management practice to maintain stands. Other

Trees placed along field to form a field wildbreak to reduce soil erosion by wind. (SCS W-3659-15)

practices, such as land shaping and straw mulching, may be necessary during establishment periods.

The practices mentioned above will adequately take care of most erosion problems. However, conditions are such that about 1 year in 10 at lower elevations, and 2 years in 10 at higher elevations, the practices will not completely control cropland erosion. These conditions are caused by rain on frozen soil. Another problem encountered in the subregion is heavy wind driven snows. This occurs 1 year in 10 to 20. Diversions, waterways, and channels have drifts that block flows during snow-melt.

Most erosion problems will be solved by individual land-owners with cost sharing and technical assistance from public funds.

Flooding

To protect the 86,000 acres of cropland from the ravages of flooding, two kinds of practices are normally used. Damage from floods can be reduced by providing adequate stream channel

capacity by enlarging channels or developing adequate levees to keep the water within the present channels. Storage is another method of flood protection. This method can often control or regulate high volume, short duration floods. It helps to protect against erosion, deposition and pollution. It also provides additional multipurpose benefits for other types of water uses, such as irrigation, municipal and industrial development, fish and wildlife enhancement and for recreation.

The convection type storms, commonly called cloudbursts, which generally occur in late spring and summer, are quite difficult to protect against. However, protective measures discussed above also apply to this kind of flood. Selective measures designed to improve the stream channels and protect against floods are presented in table 329.

Table 329 - Cumulative Cropland Flood Protection Practices, Subregion 7

Practice	1966	1980	2000	2020
	Miles			
Stream Channel Imp.	338	1,570	3,200	4,850
Streambank Protection	49	220	450	680
Stream Channel Stab.	4	40	80	120
Dikes and Levees	41	180	370	560

Source: Soil Conservation Service, C-NPRBS Projections.

A combination of selective measures is recommended that will provide protection to growing crops, prevent erosion and provide for the orderly removal of water in excess of what can, under normal conditions, infiltrate into the soils.

Program Costs

The estimated cost of providing for the conservation and improvement of the subregion's cropland is presented in table 330.

Table 330 - Estimated Cost of Cropland Conservation Practices, Subregion 7

Item	Water Conservation	Drainage	Erosion Control	Flood Control	Total
			($1,000)		
1966-1980					
Private Funds	353,367	1,694	48,342	1,001	404,404
Public Funds	86,408	672	5,915	1,484	94,479
Technical Cost 1/	10,749	579	5,601	250	17,179
Total	450,524	2,945	59,858	2,735	516,062
1981-2000					
Private Funds	797,060	3,710	112,740	2,790	916,300
Public Funds	170,060	1,580	13,790	5,780	191,210
Technical Cost 1/	26,643	1,296	12,326	860	41,125
Total	993,763	6,586	138,856	9,430	1,148,635
2001-2020					
Private Funds	1,181,290	5,490	174,620	4,660	1,366,060
Public Funds	236,140	2,360	21,360	9,660	269,520
Technical Cost 1/	41,428	1,928	17,253	1,430	62,039
Total	1,458,858	9,778	213,233	15,750	1,697,619

1/ Includes public and private costs.
Source: Soil Conservation Service, C-NPRBS Projections

Forest Land

Increasing needs for lumber, plywood, pulpwood, and other forest uses will create additional timber production demands on the forest lands of the subregion. Meeting these needs will require accelerating levels of watershed protection, reduction in present sediment levels, and increased stream flows through vegetation and snowfield management. These land treatment practices must complement the structural programs designed to develop the water potential of an area.

Watershed Protection

It is anticipated that the present standards of watershed protection conducted concurrently with logging and road construction, as outlined in table 311, will be improved on the public forest lands. By the year 2020, standards on private areas should be at least on a level of those presently utilized on the public areas, especially on sites with a high erosion or sediment yield potential. Table 331 outlines the required practices and

anticipated total cost accumulated through the year 2020. These costs are based on the assumption that: (1) On the public forest lands, controls through timber sale and construction contracts are adequate if properly applied, and (2) on the private forest lands, the minimum required in year 2020 will at least meet standards presently in force on public lands.

Table 331 - Projected Costs for Watershed Protection Practices, Forest Land, Subregion 7

Practices	Unit	Total Units 1/	Total Cost 1/ $1000
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	392,000	7,840
Harvest Road Treatment 2/	Mi.	15,700	3,925
Other Watershed Requirements 3/	Ac	6,037,000	141,190
Total Cost			152,955
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	227,000	3,405
Harvest Road Treatment	Mi.	9,000	1,800
Other Watershed Requirements	Ac.	1,763,000	57,948
Total Cost			63,153
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	619,000	11,245
Harvest Road Treatment	Mi.	24,700	5,725
Other Watershed Requirements	Ac.	7,800,000	199,138
Total Cost			216,108

1/ Total for 55 year period 1965-2020. Costs in 1969 dollars.
2/ Includes road maintenance
3/ Includes watershed surveys, plans, fire protection, timber cultural practices, special road requirements and other indirectly related items.

At the rate projected in table 331, recurrent watershed protection measures will cost about $2,780,000 annually on the public forest lands and should cost about $1,150,000 annually on the private forest land. Converting the annual costs to totals, this amounts to $216,108,000. This represents the cost of maintaining the productive condition of the forest watersheds under the pressure of the projected demands.

Watershed Rehabilitation

Forest areas with the highest incidence of erosion are in the medium through very high sediment yield category. (table 310) These areas presently contribute about 110 acre-feet of sediment per year or 22 percent of the total load.

Treatment needs and the amount to be accomplished during time periods 1980, 2000, and 2020 are listed in table 332. Table 333 outlines the anticipated sediment reduction through the application of these measures.

Table 332 - Projected Watershed Rehabilitation Programs, Forest Land, Subregion 7

Program	Unit	Amount	Cost 1/ $1000	Amount	Cost 1/ $1000	Amount	Cost 1/ $1000
FEDERAL LANDS							
Land Treatment	Ac.	30,100	16,501	20,100	11,001	15,100	8,251
Stream Rehabilitation	Mi.	726	677	815	941	721	961
Road Rehabilitation	Mi.	2,015	901	1,126	496	40	1
Total Cost			18,079		12,438		9,213
NON-FEDERAL LANDS							
Land Treatment 2/	Ac.	60,300	812	105,900	1,332	107,800	1,345
Stream Rehabilitation	Mi.	34	31	85	251	49	98
Road Rehabilitation	Mi.	405	12	634	19	320	10
Total Cost			855		1,602		1,453
TOTAL ALL LANDS							
Land Treatment	Ac.	90,400	17,313	126,000	12,333	122,900	9,596
Stream Rehabilitation	Mi.	760	708	900	1,192	770	1,059
Road Rehabilitation	Mi.	2,420	913	1,760	515	360	11
Total Cost			18,934		14,040		10,666

1/ In 1969 dollars.
2/ SCS River Basin Survey Data.

Erosion control practices are expected to reduce sediment yield by 25 percent or 130 acre-feet per year. Medium and very high categories will receive the most intensive watershed treatment and should show the most reduction. These areas are related

Table 333 - Expected Annual Sediment Reduction
Forest Land Rehabilitation, Subregion 7

Present Yields 1/	Acres (1,000)	Total Sed. Yield Ac-ft./Yr.	Acres Treated 2/	Sediment Reduction Ac-ft./Yr.
Very low	6,876.8	215	--	--
Low	1,160.3	181	219,000	27.4
Medium	280.3	88	280,000	78.8
High	--	--	--	--
Very high	10.9	25	11,000	22.1
Total	8,328.3	509		128.3
		Total reduction, percent 25		

1/ Data from table 310.
2/ Data from table 332. Miles treated converted to acres.

to activities such as timber harvest, road construction, and other forest land use operations.

Typical gully stabilization work on forest range land in the southeast corner of the subregion is shown in the accompanying photograph. This work includes gully stabilization through "gully plugs" and cover seeding. Fencing is used to exclude livestock until stabilization is complete.

In addition to erosion control needs, nonrecurrent work will be required on future forest burns and lands adjacent to future water storage projects. These sources will be treated as the need arises. Therefore, the 25 percent overall reduction is that amount possible should no new sources occur through fire or other natural disaster.

Water Yield Improvement

The projected water yield improvement opportunities and the amount that should be accomplished during time periods 1980, 2000, and 2020 are shown in table 334. Timber cover on the private forest lands is modified principally to meet silviculture requirements. Therefore, neither water yield improvement practices nor benefits are estimated, although some benefit does occur.

Typical gully stabilization work on forest range. (Forest Service)

Table 334 - Projected Water Yield Improvement Practices
Public Forest Land, Subregion 7

Program	Unit	1980 Amount	1980 Cost 1/ ($1000)	2000 Amount	2000 Cost 1/ ($1000)	2020 Amount	2020 Cost 1/ ($1000)
Cover Manipulation 2/	Ac.	10,000	320	15,000	248	33,700	533
Snowpack Management	Mi.	50	2,500	50	2,500	60	3,000
Water Spreading 3/	Ac.	5,000	273	8,600	408	15,000	600
Total Cost			3,093		3,156		4,133

1/ In 1969 dollars.
2/ Includes type conversion and riparian vegetation management.
3/ Planned for altering timing of runoff or groundwater recharge, not for irrigation or other resource activity.

Total Program Costs

In summary the total cost of forest watershed protection and land treatment programs through the year 2020 may be expressed as follows:

	Costs ($1000)
Watershed Protection	216,108
Watershed Rehabilitation	43,640
Water Yield Improvement	10,382
	270,130

Rangeland

Measures and Practices for Watershed Protection

Rangeland watershed protection, rehabilitation and improvement practices to meet future needs in Subregion 7 are shown on tables 335, 336 and 337. Most of these practices which improve watershed conditions also have other management

Table 335 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Subregion 7 1/

Measures & Practices	Units	Land Ownership Public 3/	Land Ownership Private	Land Ownership Total	Watershed Purposes 2/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	238,200	483,000	721,200	-	x	x	x
Brush Control	Acres	136,200	417,300	553,500	-	x	x	x
Weed Control	Acres	83,800	256,700	340,500	-	x	-	-
Fertilizing	Acres	67,500	206,900	274,400	x	x	x	x
Contouring, Pitting, Furrowing	Acres	7,900	24,100	32,000	x	x	x	-
Deep Tillage	Acres	2,500	7,500	10,000	-	x	x	-
Stream & Bank Stabilization	Acres	300	800	1,100	x	x	x	x
Waterspreading	Acres	3,800	11,600	15,400	x	x	x	x
Irrigation	Acres	500	1,600	2,100	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,900	6,000	7,900	-	x	x	-
Reducing Excessive Grazing Use	Acres	314,000	961,900	1,275,900	-	x	x	x
Livestock & Game Water Facilities	Number	900	2,600	3,500	-	x	x	x
Special Fire Control	Acres	48,000	147,200	195,200	-	x	x	-
Road Stabilization								
Existing Roads	Miles	400	1,300	1,700	x	x	x	-
New Roads	Miles	10	40	50	x	-	x	-
Stream Clearance	Miles	4	12	16	x	x	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	500	1,600	2,100	x	x	x	x
	Acre Ft.	200	600	800	x	x	x	x
Detentions	Number	15	40	55	x	x	-	-
	Cu. Yds.	61,500	188,500	250,000	x	x	-	-
Check Dams (Gully Plugs)	Number	1,100	3,300	4,400	-	-	x	x
	Cu. Yds.	45,400	139,200	184,600	-	-	x	x
Dikes	Lin. Ft.	15,400	47,000	62,400	x	-	x	x
Diversions	Number	30	90	120	x	x	x	x
	Cu. Yds.	44,900	137,700	182,600	x	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.

Table 336 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1981 to 2000, Subregion 7 1/

Measures & Practices	Units	Land Ownership: Public 3/	Land Ownership: Private	Total	Watershed Purposes 2/: (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	240,700	485,300	726,000	-	x	x	x
Brush Control	Acres	154,100	472,000	626,100	-	x	x	x
Weed Control	Acres	78,800	241,300	320,100	-	x	x	-
Fertilizing	Acres	22,100	67,700	89,800	-	x	x	-
Conversion of tree cover to grass	Acres	3,700	11,300	15,000	-	x	x	-
Contouring, Pitting, Furrowing	Acres	8,000	24,500	32,500	-	x	x	-
Deep Tillage	Acres	600	1,900	2,500	x	x	x	-
Stream & Bank Stabilization	Acres	400	1,400	1,800	x	x	x	x
Waterspreading	Acres	9,700	29,700	39,400	x	x	x	x
Irrigation	Acres	1,500	4,600	6,100	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,900	5,800	7,700	-	x	x	-
Reducing Excessive Grazing Use	Acres	221,000	677,200	898,200	-	-	x	x
Livestock & Game Water Facilities	Number	1,100	3,400	4,500	-	-	x	-
Special Fire Control	Acres	67,000	205,000	272,000	-	x	x	-
Road Stabilization								
Existing Roads	Miles	500	1,600	2,100	x	x	x	-
New Roads	Miles	25	75	100	x	-	x	-
Stream Clearance	Miles	2	6	8	x	x	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	300	900	1,200	x	x	x	x
	Acre Ft.	300	800	1,100	x	x	x	x
Detentions	Number	15	50	65	x	x	x	-
	Cu. Yds.	79,500	243,500	323,000	x	x	x	-
Check Dams (Gully Plugs)	Number	1,400	4,400	5,800	-	-	x	x
	Cu. Yds.	94,700	290,000	384,700	-	-	x	x
Dikes	Lin. Ft.	19,600	60,200	79,800	x	-	x	x
Diversions	Number	20	65	85	x	x	x	x
	Cu. Yds.	27,000	82,800	109,800	x	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.

2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.

3/ Includes Federal, State, County and Municipal Ownership.

Table 337 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2001 to 2020, Subregion 7 1/

Measures & Practices	Units	Land Ownership: Public 3/	Land Ownership: Private	Total	Watershed Purposes 2/: (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	2[illegible]2,800	528,200	791,000	-	x	x	x
Brush Control	Acres	399,700	1,224,500	1,624,200	-	x	x	x
Weed Control	Acres	29,000	89,000	118,000	-	x	x	-
Fertilizing	Acres	25,800	79,000	104,800	-	x	x	-
Conversion of tree cover to grass	Acres	8,600	26,300	34,900	-	x	x	-
Contouring, Pitting, Furrowing	Acres	10,400	32,000	42,400	-	x	x	-
Deep Tillage	Acres	600	1,900	2,500	-	x	-	-
Stream & Bank Stabilization	Acres	600	1,900	2,500	x	x	x	x
Waterspreading	Acres	20,900	64,000	84,900	x	x	x	x
Irrigation	Acres	3,400	10,600	14,000	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,300	4,000	5,300	-	x	x	-
Reducing Excessive Grazing Use	Acres	6,100	18,800	24,900	-	-	x	x
Livestock & Game Water Facilities	Number	1,600	4,700	6,300	-	-	x	x
Special Fire Control	Acres	47,900	146,700	194,600	-	x	x	-
Road Stabilization								
Existing Roads	Miles	500	1,700	2,200	x	x	x	-
New Roads	Miles	12	37	49	x	-	x	-
Stream Clearance	Miles	15	46	61	x	x	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	300	1,100	1,400	x	x	x	x
	Acre Ft.	200	700	900	x	x	x	x
Detentions	Number	25	75	100	x	x	x	x
	Cu. Yds.	109,300	334,800	444,100	x	x	x	x
Check Dams (Gully Plugs)	Number	400	1,400	1,800	-	-	x	x
	Cu. Yds.	112,700	345,300	458,000	-	-	x	x
Dikes	Lin. Ft.	16,000	48,900	64,900	x	-	x	x
Diversions	Number	35	100	135	x	x	x	x
	Cu. Yds.	47,900	146,700	194,600	x	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.

2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.

3/ Includes Federal, State, County and Municipal Ownership.

Table 338 - Sediment Yield Projections from Rangeland, Subregion 7

Sediment Yield Categories 1/	1966	1980	2000	2020
		Rangeland Acreage (1,000 Acres)		
Very Low	5,358.4	5,248.5	5,280.0	5,275.0
Low	134.4	314.9	498.1	676.1
Medium	704.0	498.6	312.7	126.6
High	131.8	94.9	61.6	28.3
Very High	29.5	19.1	9.6	--
Total	6,358.1	6,176.0	6,162.0	6,106.0
Percent Change from 1966	.0	-2.9	-3.1	-4.0
		Annual Sediment Yield (Acre-Feet)		
Very Low	502	492	495	495
Low	32	74	117	158
Medium	385	273	171	69
High	206	148	96	44
Very High	127	82	41	--
Total	1,252	1,069	920	766
Percent Change from 1966	0	-15	-27	-39

1/Very Low through Very High Categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.

Improved Range Condition and Capacity

Estimated future range improvement (shown on table 339) will result from accomplishment of required measures and practices for watershed rehabilitation and protection, shown in tables 335, 336, and 337, and from other management practices for improved production capacity of the range. Good condition range will be increased from 19 percent to 79 percent of the total range acreage by 2020, or from 1.2 million acres to 4.8 million acres. Poor condition range which, in 1966, accounted for 45 percent of the total rangeland, will be decreased to 7 percent by 2020, or from 2.9 million acres to 418,000 acres. With an improved range

Table 339 - Estimated Potential Rangeland Improvement, Subregion 7

Range Type and Condition	1966 Acres (1,000)	1966 AUM's (1,000)	1980 Acres (1,000)	1980 AUM's (1,000)	2000 Acres (1,000)	2000 AUM's (1,000)	2020 Acres (1,000)	2020 AUM's (1,000)
Grassland								
Good	474.1	182.4	668.7	257.2	938.6	361.0	1,269.2	488.2
Fair	1,071.4	178.6	906.9	151.2	684.3	114.1	369.7	61.6
Poor	1,531.7	127.6	1,020.5	85.0	618.7	51.5	175.3	14.6
Seeded Range	232.8	89.5	881.0	338.8	1,460.1	561.6	2,125.2	817.4
Total	3,310.0	578.1	3,477.1	832.2	3,701.7	1,088.2	3,939.4	1,381.8
Sagebrush								
Good	395.5	98.9	560.5	140.1	936.3	234.1	1,131.7	283.0
Fair	907.9	113.5	755.8	94.5	411.6	51.4	225.0	28.1
Poor	1,034.4	68.9	692.6	46.2	424.0	28.3	127.8	8.5
Total	2,337.8	281.3	2,008.9	280.8	1,771.9	313.8	1,484.5	319.6
Other Brush								
Good	125.2	41.7	160.9	53.7	223.8	74.6	292.5	97.5
Fair	269.8	38.6	253.4	36.2	285.9	40.8	274.5	39.2
Poor	315.3	15.7	275.7	13.7	178.7	8.9	115.1	5.7
Total	710.3	96.0	690.0	103.6	688.4	124.3	682.1	142.4
Total								
Good 1/	1,227.6	412.5	2,271.1	789.8	3,558.8	1,231.3	4,818.6	1,686.1
Fair	2,249.1	330.7	1,916.1	281.9	1,381.8	206.3	869.2	128.9
Poor	2,881.4	212.2	1,988.8	144.9	1,221.4	88.7	418.2	28.8
Grand Total	6,358.1	955.4	6,176.0	1,216.6	6,162.0	1,526.3	6,106.0	1,843.8
Average AC/AUM	6.7		5.1		4.0		3.3	
Percent Change from 1966	.0	.0	-2.9	+27.3	-3.1	+59.8	-4.0	+93.0

1/ Includes seeded range.
Source: Table 313 "Present Status" rangeland narrative. Future estimates for this study are based on representative on-site surveys for production guides with consideration to the capability of the range for improvement with proper management and utilization.

Proper distribution of livestock for the grazing capacity of the range is frequently limited by inadequate stock water supplies. Additional water supplies should be developed. On this good condition range north of McNary Reservoir, pipe is being laid to distribute water for range livestock. (SCS W-2091-8)

condition and a decline in total rangeland acreage by 2020, the 1966 grazing capacity of 955,000 animal unit months is expected to increase to 1,844,000 animal unit months in 2020, an increase of 93 percent.

Even with this significant improvement in range condition and grazing capacity, range forage production will meet only about 9.3 percent of the anticipated demand for livestock production in Subregion 7 by 2020 compared to 11.9 percent in 1966.

Estimated Program Investment Costs

Broad investment cost estimates (based on 1969 dollars) are shown in table 340 for all future measures and practices listed in tables 335, 336, and 337. Cover improvement and soil stabilization programs will require $19.3 million between 1966 and 2020 or 58 percent of the total $33.0 million rangeland watershed costs. Watershed oriented land management practices require $7.9 million or 24 percent of the total, and water control structures require $5.8 million or 18 percent of all costs.

Table 340 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Subregion 7 1/

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
		Public Land		
Cover Improvement and Soil Stabilization	1,413.3	1,676.4	2,395.0	5,484.7
Watershed Oriented Land Management Practices	691.6	784.7	698.8	2,175.1
Water Control Structures	597.2	513.1	380.5	1,490.8
Total	2,702.1	2,974.2	3,474.3	9,150.6
		Private Land		
Cover Improvement and Soil Stabilization	3,367.7	4,173.7	6,286.4	13,827.8
Watershed Oriented Land Management Practices	1,082.7	2,431.2	2,201.0	5,714.9
Water Control Structures	1,530.6	1,552.5	1,260.1	4,343.2
Total	5,981.0	8,157.4	9,747.5	23,885.9
		Total		
Cover Improvement and Soil Stabilization	4,781.0	5,850.1	8,681.4	19,312.5
Watershed Oriented Land Management Practices	1,774.3	3,215.9	2,899.8	7,890.0
Water Control Structures	2,127.8	2,065.6	1,640.6	5,834.0
Total	8,683.1	11,131.6	13,221.8	33,036.5

1/ Based on measures and practices shown on Tables 387, 388 and 389 with constant 1969 dollars.

Based on the present ratio of rangeland ownership, an estimated $23.9 million or 72 percent will be needed for the private range. The public range will require $9.1 million or 28 percent of the total.

Other Land

Flood protection in urban areas can be greatly enhanced by flood detention reservoirs, enlarged or improved channels and by dikes and levees. Land treatment measures are also essential to prevent silting in the channel. Silt deposition reduces the channel capacity and creates costly maintenance of the channel to keep it functioning properly.

Flood protection is presently required on 3,400 acres of urban area. This protection can be accomplished by developing a combination of reservoir detentions, channel enlargements, and properly treated watersheds. Urban area works of improvement are

generally designed to provide protection against storms of 1 in 100 year probability.

Community-wide resource planning and development projects have broadened the scope of conservation. These projects vary from small urban areas to multi-county efforts and include group drainage projects, lawn and bank stabilization, street and alley protective measures and similar programs.

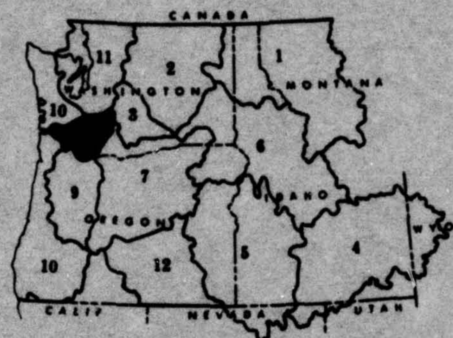
Soil surveys and interpretive analysis can provide adequate land resource information to urban planning bodies. These agencies can use this information to determine future hazards in urban development and to avoid problems before they occur. Many urban developments could have easily avoided what are now serious problems if the planners had used available data or had requested planning assistance.

One of the more common problems in urban developments is the use of septic tank drain fields. This problem not only causes undesirable inconveniences along with a continual expense to keep the system operating, but the constant threat to the health of the neighborhood is of prime importance. The most logical method of avoiding this type of problem is to obtain an adequate soil analysis of the area involved to guide in the design of septic tank drain field systems.

There are a number of possible solutions to problems such as those listed above: (1) The development sites being planned can be eliminated; (2) other areas can be planned for uses that are compatible with this type of problem; (3) allow only the type of development most tolerant to this type of problem; (4) zone the area for the type of development that suffers the least extensive dollar damages and causes less burdensome inconveniences; (5) remove the problems by preventive measures at the outset.

Planning today for tomorrow's needs has reached the critical stage, since the total land area will reduce slightly between now and the year 2020 and population will more than double in the subregion. This population will require more than 20,000 acres of land primarily in urban developments to provide living space. Most of this transfer in land use will come from lands presently used as cropland or rangeland.

Most of the necessary structures and practices necessary to protect other lands have been included and costed elsewhere in this appendix and in Appendices VII, Flood Control; IX, Irrigation; XI, Municipal and Industrial Water Supply; and XII, Water Quality and Pollution Control.



LOCATION MAP

SUBREGION 8

SUBREGION 8
LOWER COLUMBIA

PRESENT STATUS

Subregion 8, the Lower Columbia, lies west of the Cascade Range in southwest Washington between the Cowlitz River on the north and the Columbia River on the south. The area is slightly less than 2 percent of the Columbia-North Pacific Region and includes 3.2 million acres of land and 73,000 acres of large water areas. Nearly 58 percent is private land; the remaining 42 percent is in public ownership, principally national forest and state-owned forest lands.

The annual precipitation decreases from 90 inches on the west side of the Coast Range to 50 inches in the lower river valleys, then increases to 100 inches or more in the wettest areas along the windward slope of the Cascades. In the lowlands snowfall seldom exceeds 10 to 15 inches or remains on the ground longer than 2 weeks. Snowfall increases in the mountains and can be expected any time between October and June. The agricultural areas have a frost-free season that varies from approximately 140 days in the cooler valleys to 180 days in the warmer valleys. This period runs generally from mid-April until mid-October.

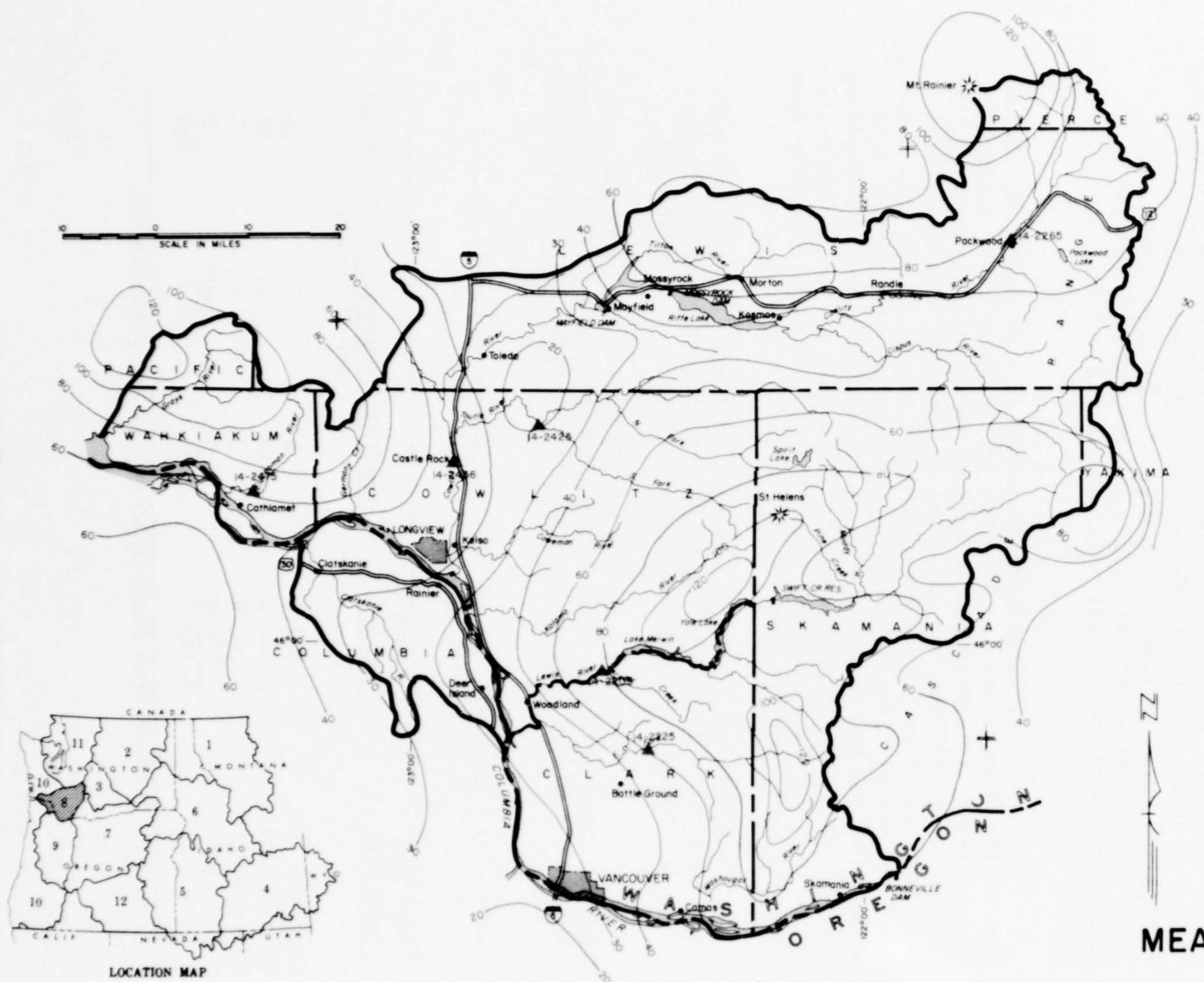
Total stream discharge averages 18.1 million acre-feet per year. Over 16 million acre-feet, 90 percent, originate on forest lands, the balance from cropland and pasture areas (figure 49).

Highest recurrent sediment yields are in the cropland areas. Areas of temporary high yield result from logging and road construction on some of the steeper mountain slopes (table 341 and figure 50).

Table 341 - Generalized Sediment Yield by Cover and Land Use, Subregion 8

Cover and Land Use	1,000 Acres	Percent	Sediment Yield (ac.-ft./year)	Percent
Cropland	201.1	6	53	10
Forest Land	2,665.0	84	423	79
Rangeland	67.9	2	16	3
Other Land	258.6	8	40	8
Total	3,192.6	100	532	100

Source: Derived from figures 49 and 50 and Appendix IV.



EXPLANATION

Mean annual runoff

▲390

Gaging site with Geological Survey indentification number

Notes

(1) MEAN ANNUAL RUNOFF ISOPLETHS FOR NATURAL FLOW CONDITIONS WERE DERIVED USING OBSERVED STREAM FLOWS, CLIMATOLOGICAL DATA, DEPLETIONS, AND PHYSIOGRAPHIC FEATURES OF THE BASIN FOR THE PERIOD 1931-1960.

(2) STREAM GAGING STATIONS SHOWN ARE SELECTED STATIONS AND ARE NOT THE ONLY STATIONS USED IN PREPARING THE RUNOFF MAP.

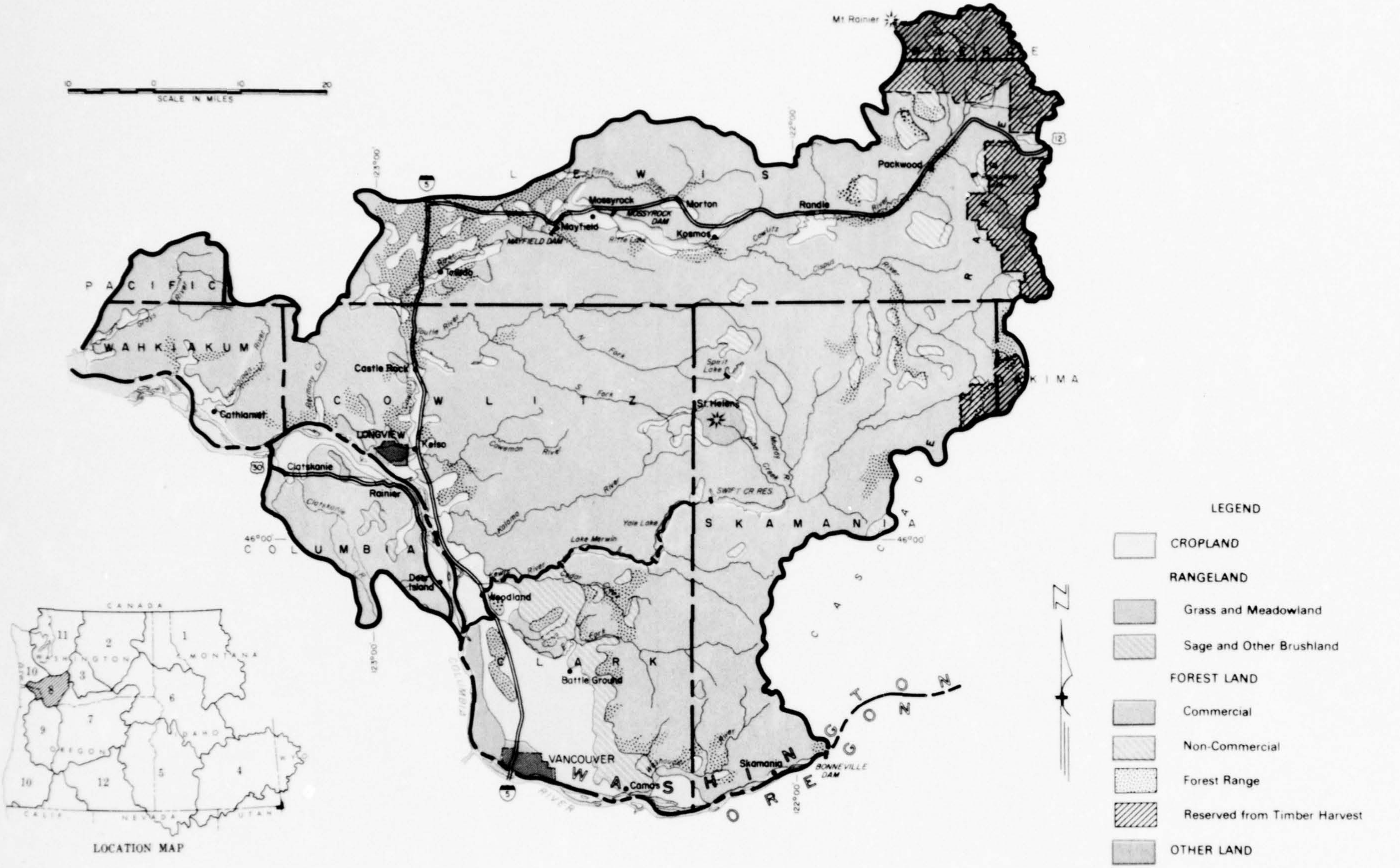
COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL RUNOFF IN INCHES

LOWER COLUMBIA SUBREGION 8

1968

FIGURE 48



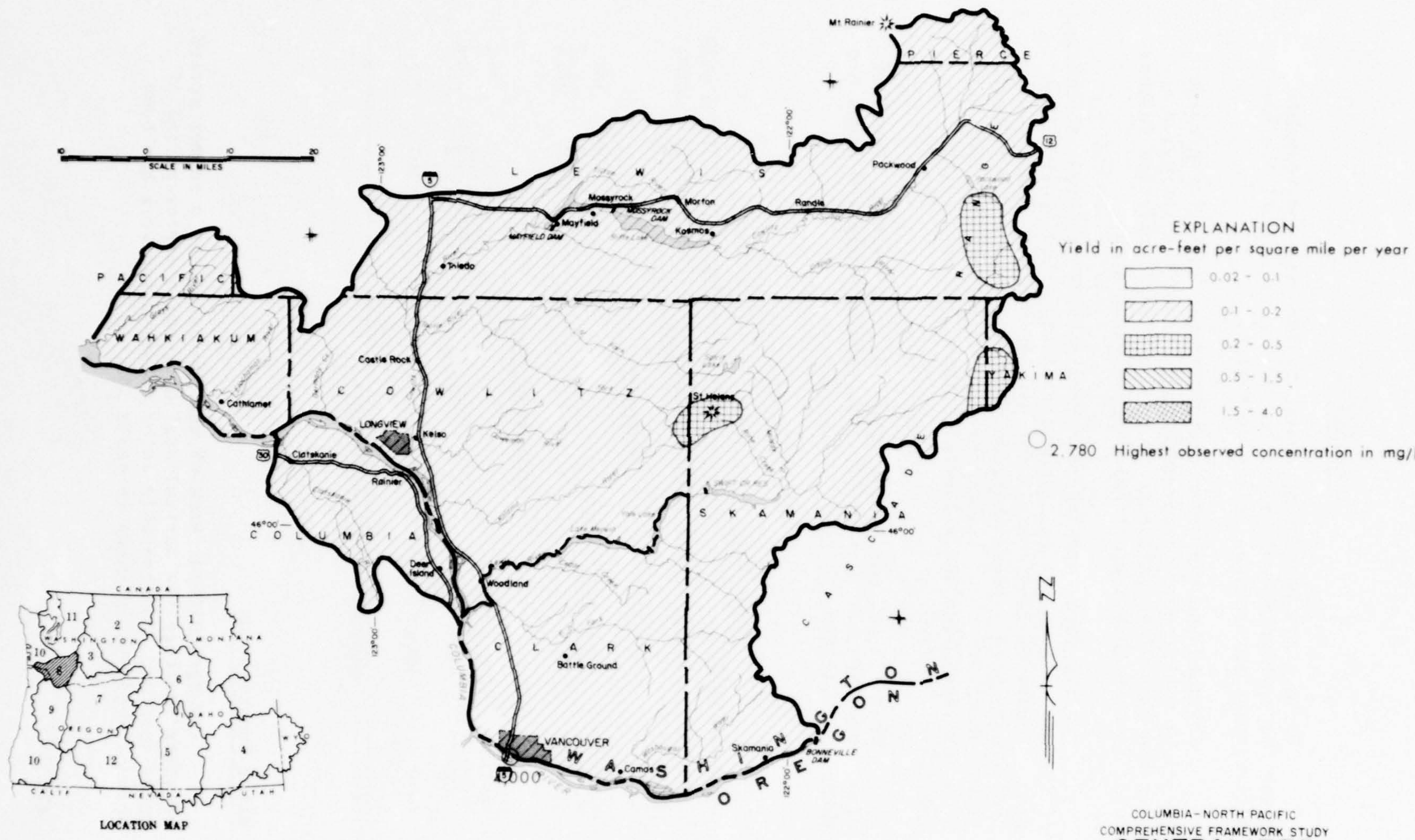
COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED COVER AND LAND USE

LOWER COLUMBIA, SUBREGION 8

1968

FIGURE 49



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

LOWER COLUMBIA SUBREGION 8

1968

FIGURE 50

Cropland

Through its meandering course to the sea, the Columbia River has fashioned broad river terraces that support the major agricultural enterprises of the subregion.

Portland and the urban centers of the subregion provide excellent market outlets for such products of the subregion as milk and eggs. The existence of good highway facilities further helps to make this a profitable agricultural area.

Poultry feeds are imported from outside the area; therefore, little use of land for this industry exists. Livestock is the greatest user of land, mainly for pasture and hay. Most of the tree fruits have a grass cover on the soil, except for filbert trees, which are clean tilled for ease of harvesting. The acreage used for vegetables and filberts is the major area being intensively tilled.

Nearly 9 percent of the cropland is irrigated. Types of crops grown and acreages of irrigated and nonirrigated crops are shown in table 342.

Table 342 - Types of Crops, Subregion 8, 1966

State	Hay & Pasture	Grain	Grass Seed	Cane Fruits & Strawberries	Mint	Bulbs & Flowers	Others	Cropland Area
				(1,000 acres)				
				Dry Cropland				
Washington	164.0	-	-	.8	-	-	1.3	166.1
Oregon	14.2	1.5	1.0	.8	-	-	.2	17.7
Total	178.2	1.5	1.0	1.6	-	-	1.5	183.8
				Irrigated Cropland				
Washington	10.3	-	-	.6	1.5	.4	3.0	15.8
Oregon	1.1	-	-	-	.2	-	.2	1.5
Total	11.4	-	-	.6	1.7	.4	3.2	17.3
Total Cropland	189.6	1.5	1.0	2.2	1.7	.4	4.7	201.1

Source: Soil Conservation Service, C-NPRBS Data.

Water Conservation

The agricultural area of the subregion has a summer period of water shortage for agricultural uses and a winter period of water surplus. Considerable water conservation work has been accomplished, as is shown in table 343.

Table 343 - Water Conservation Practices Applied on Cropland, Subregion 8, 1966

Practice	Units	Washington	Oregon	Total
Water Control Facilities	No.	713.0	4.0	717.0
Irrigation Water Conveyance Facilities	Miles	9.0	-	9.0
Water Storage Facilities	No.	58.0	-	58.0
Irrigation System, Sprinkler	No.	492.0	12.0	504.0
Land Shaping	1,000 Acs.	2.1	.1	2.3
Irrigation Water Management	1,000 Acs.	8.6	1.6	10.2

Source: Soil Conservation Service Data

Irrigation development to date has been accomplished on an individual farm basis. Most of the irrigated land is in small blocks adjacent to the streams. Individual developments pump directly from the streams or from ground water. Group developments have generally not been necessary.

Table 344 shows the irrigated lands, source of water, and method of application for the subregion. The table also shows the amount of irrigated lands that are short of water during the irrigation season.

Table 344 - Water Availability and Irrigation Methods for Cropland, Subregion 8, 1966

Item	Washington	Oregon	Total	Percent
	(1,000 acres)			
Water Source				
Streamflow	11.4	1.4	12.8	74.0
Ground Water	4.4	-	4.4	25.4
Reservoir Storage	-	.1	.1	.6
Total	15.8	1.5	17.3	100.0
Area with Adequate Supply	15.2	.7	15.9	92.0
Area with Inadequate Supply	.6	.8	1.4	8.0
Method of Application				
Sprinkler	15.8	1.5	17.3	100.0
Surface	-	-	-	-

Source: Soil Conservation Service, C-NPRBS Data.

The irrigated acreage varies from year to year, depending on available moisture, pasture conditions, and forage needs. Sprinkler systems are used for irrigation. They are better adapted than flooding systems for several reasons: (1) Water control is an important factor of soil drainage and the amount and distribution of water is better regulated by sprinklers than by flooding; (2) the water supply is generally from large rivers with relatively flat gradients, making gravity diversions difficult; (3) most of the irrigated land is adjacent to the streams and in small plots, therefore, pumping from streams is more practical than gravity diversions; (4) overflow on the irrigated land during flood stages creates a maintenance problem on ditches, diversions, and other structures associated with flood irrigation systems; (5) it is difficult to keep fields sufficiently smooth for flood irrigation where overflow occurs; and (6) sprinkler systems facilitate the control and efficient use of water by part-time farmers who of necessity cannot be present to make the frequent water changes required by flood irrigation.

Because of the relative abundance of rainfall, irrigation development has not progressed to the degree that it has in the dryer areas of the region. The irrigated acreage fluctuates from year to year, but the trend is increasing.

Constructing irrigation pond with dragline to make underground water readily accessable. (SCS F-134-4)

A high level of management is necessary to obtain the greatest returns from irrigation, which may include: Drainage, improved varieties of plants, and fertilization.

Developments to date, however, indicate that many farmers have been reluctant to make the required investments for irrigation. In the long run, the demand for dairy and livestock products and the relative competitive situation between this and other producing areas will have a bearing on the irrigation development in this subregion.

Drainage

There are 87,700 acres of cropland in this subregion that are excessively wet (table 345). Through 1966, about 16,000 acres have been drained, and most of the remaining 72,000 acres have drainage problems limiting general crop production.

Table 345 - Cropland Areas with a Wetness Problem, Subregion 8, 1966

Capability Class	Washington	Oregon (1,000 acres)	Total
II	76.7	8.8	85.5
III	1.7	.2	1.9
IV	0.2	.1	.3
Total	78.6	9.1	87.7

Source: Soil Conservation Service, C-NPRBS Data.

There are three problems of cropland drainage common in this subregion. One is the ponding of water from runoff, and from streambank overflow, which usually occurs on the flood plains. The ponding is often due to a higher ground elevation near the stream than that area which is to be drained. Also, the stream surface may be higher than the surrounding ponded water, thereby prohibiting natural surface drainage. The problem has usually been solved by excavating a ditch from the pond to the stream. The ditch will usually be constructed parallel with the stream for several hundred feet so as to reach an elevation above the stream surface.

The second problem is that of a high water table. The most common drainage method to remedy this situation is to place tile in such a manner as to lower the water table to an acceptable depth. Many of the soils are too dense for efficient internal draining.

Drainage of cropland will usually make it possible to increase the number of crops that can be grown, as well as to lengthen the growing season.

Many areas are subject to frequent overflow. Such areas are often protected by dikes and outlet drain ditches equipped with floodgate structures to prevent high water from causing reverse flows that add to the drainage problem. The same type of installations are used on the tidelands.

The seepage of waters from higher elevations onto low-lying areas is a common problem. This condition is usually remedied by using an intercepter tile or ditch. Random or pattern type tile systems are necessary to drain areas with high water table problems. Drainage measures applied to cropland through 1966 are shown in table 346.

Table 346 - Drainage Practices Applied to Cropland, Subregion 8, 1966

Practices	Units	Washington	Oregon	Total
Conduits and Ditches	Miles	780	83	863
Structures	No.	374	427	801

Source: Soil Conservation Service Data.

Erosion and Sedimentation

Erosion is currently a problem on 9,700 acres, or nearly 5 percent of the cropland. Soil surveys show 61,800 acres of cropland soils with erosion being the major limitation. Table 347 shows the acreage of potentially erodible soils by capability class.

Table 347 - Cropland Areas with an Erosion Potential by Capability Class, Subregion 8, 1966

Capability Class	Washington	Oregon	Total
		(1,000 acres)	
II	46.0	0.9	46.9
III	8.0	6.1	14.1
IV	0.6	0.2	0.8
Total	54.6	7.2	61.8

Source: Soil Conservation Service, C-NPRBS Data.

Erosion control practices have been applied on about 85 percent of the land where erosion has limited cropland use. Practices applied through 1966 are shown on table 348.

Table 348 - Erosion Control Practices Applied on Cropland
Subregion 8, 1966

Practice	Units	Washington	Oregon	Total
Grade Stabilization Structures	No.	21	--	21
Diversions and Terraces	Miles	2	1	3
Ditch Bank Seeding	Miles	196	--	196
Crop Residue Use	1,000 Acs.	23	1	24
Grassed Waterway	Acres	14	2	16
Conservation Cropping System	1,000 Acs.	104	17	121
Pasture and Hayland Planting	1,000 Acs.	41	9	50

Source: Soil Conservation Service Data.

Flooding

There are more than 75,200 acres of cropland subject to flooding at about a 10 percent frequency. The major areas of flooding are the Columbia River and tributary drainages.

The Columbia River may be nearly full for an extended period during May and June from spring runoff. There are numerous reservoirs on the Columbia River that are used to reduce extremely high flows. Releases from the reservoirs help to lengthen the period of high flow. The high flows during spring, plus high tides and a strong west wind during the winter can cause severe flooding and streambank erosion.

Flooding of tributary drainages to the Columbia River is most likely to occur during the heavy precipitation period from November to March, but may occur as early as September or as late as May. Fairly continuous rainfall during this period saturates the soil and causes heavy runoff from the steep, upper portions of the watersheds. Usually very little of the precipitation is retained in the form of snow. When this heavy runoff reaches the lower portions of the streams with flatter gradients, the water overflows the channel, floods many of the fields, and drops sediment and debris on fields and in canals and natural streams.

Preparing streambank for riprapping to control bank erosion during high water flows. (SCS W3880-2)

Table 349 shows some of the measures applied primarily for flood protection.

Table 349 - Flood Protection Measures Applied in Cropland Areas, Subregion 8, 1966

Practice	Units	Washington	Oregon	Total
Stream Channel Improvements	Miles	59	-	59
Streambank Protection	Miles	117	2	119
Stream Channel Stabilization	Miles	13	-	13
Dikes and Levees	Miles	128	-	128

Source: Soil Conservation Service Data.

Some damage occurs when abnormally high tides and severe winter storms coincide. Dikes and tidegates have been installed to protect many areas, but some of these structures are inadequate or in need of repair. Many other areas are entirely without such protection.

Total average annual flood damages are estimated in Appendix VII, Flood Control, to be over $3.1 million.

Agricultural damages, consisting primarily of crop and property losses, account for much of the total evaluated flood damage. Floods in the fall and spring frequently cause loss of all or part of the early or late crops and inundate farm irrigation pumping plants and other equipment left in the fields. Winter and spring floods damage crops by washing out roots, seeds, and seedlings, and by burying small plants and seed under sediment. Because of serious drainage problems and frequent flooding, many areas have not been developed for cropland.

Forest Land

Forest land covers nearly 2.7 million acres or 83 percent of the land area in the subregion. About 56 percent is in private ownership, while 44 percent is owned by Federal, State, and local governments. Of this total, 93 percent is commercial and only 7 percent is noncommercial.

The commercial forest land presently supports almost 97 billion board feet of merchantable timber, 56 percent on public land and 44 percent on private. It furnishes the raw material for a forest products industry that employs 74 percent of the subregion's manufacturing force. In 1964, the timber harvest amounted to

Grazing in the mountain meadows in the subalpine timber type. Commercial forest land in the Tatoosh Range is in the background. (Forest Service)

2.4 billion board feet. Grazing use is limited to the high alpine areas and scattered private woodlands.

Nearly 90 percent of all streamflow in the subregion comes from these forest lands. Sixty-eight percent of the urban population depends on these watersheds for much of their domestic water.

Because the subregion's forest area is the source of most of the streamflow, it is also the source of much of the stream's sediment loads. Nearly 80 percent of the subregion's total sediment yield comes from forest land, the result of a combination of glacial activity in the alpine and barren areas, and a heavy timber harvest program. The average sediment yield from these sources is over 400 acre-feet per year (table 350).

Table 350 - Present Sediment Yield, Forest Land, Subregion 8

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield: Acre-feet per Square Mile	Annual Sediment Yield: Total Acre-feet	Percent
Very low	-	-	0.02 - 0.1	--	--
Low	2,626.0	99	0.1 - 0.2	411	97
Medium	39.0	1	0.2 - 0.5	12	3
High	-	-	0.5 - 1.5	--	--
Very high	-	-	1.5 - 4.0	--	--
Total	2,665.0	100		423	100

Source: Derived from figures 49 and 50.

Nearly all the forest land is in the low yield category, with sedimentation the result of both natural erosion and logging and road construction. The remainder, in the medium yield category, is from the alpine glaciers. Most watershed rehabilitation work is presently conducted on key watershed problem areas within the low category.

Watershed Protection

In this subregion, timber is generally harvested in blocks or clear-cut units. Cable yarding systems are used throughout the area. Logs from small cutting areas are removed with mobile yarders, operating along roads. Some timber salvage areas on the more gentle terrain are logged by cable equipment or crawler tractors. Extensive road systems are required with all logging operations.

Tractor trails and firelines around harvest areas are cross-drained. The more critical areas are seeded to grass. This reduces not only sheet erosion but also furnishes forage for wildlife. The results of this type of work on a harvest unit in the Gifford Pinchot National Forest are pictured below.

Temporary roads are usually cross-drained to prevent gullying and reduce runoff. Logging debris, cull logs, and other material are removed from major water courses and steep draws, reducing channel erosion, and damage to downstream fish habitat and other improvements.

One large private timber company in the subregion uses fixed-wing aircraft to locate forest problem areas. These include blowdown or logjam areas and insect and beetle damage. Flights are also used to check progress of work on watershed cleanup. In this way, wind damaged timber removal and debris cleanup work are kept current.

Seeded fireline. The harvest area is to the right. (Forest Service)

Most permanent log-hauling roads are gravel surfaced and have permanent culverts. In most areas, particularly at the crossing points on anadromous fish streams, excavated material is endhauled and deposited away from the water areas. Exposed cutbank and fill slopes are seeded to grass where erosion might deposit sediment in live streams. Although this work was originally done by hand, most seed and mulch is now applied by equipment such as the hydroseeder pictured below.

Reforestation measures include both planting and aerial seeding. Natural reproduction is protected from both burning and logging activity by on-the-ground administration. Where natural stocking is unsuccessful, artificial restocking is then undertaken.

Hydro-seeder spreading a mixture of grass seed and mulch on a cutbank along a forest road in the subregion. (Forest Service)

Table 353 - Rangeland Condition and Capacity, Subregion 8, 1966

Range Type and Condition	Ownership					
	Public		Private		Total	
	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)
Grassland						
Good	.8	.4	3.6	2.0	4.4	2.4
Fair	.8	.2	6.3	1.3	7.1	1.5
Poor	1.4	.2	12.9	1.4	14.3	1.6
Seeded Range 1/	--	--	.7	1.4	.7	1.4
Total	3.0	.8	23.5	6.1	26.5	6.9
Sagebrush						
Good	--	--	--	--	--	--
Fair	--	--	--	--	--	--
Poor	--	--	--	--	--	--
Total	--	--	--	--	--	--
Other Brush						
Good	5.5	1.6	5.9	1.8	11.4	3.4
Fair	5.6	.7	7.2	.9	12.8	1.6
Poor	6.9	.4	10.3	.6	17.2	1.0
Total	18.0	2.7	23.4	3.3	41.4	6.0
Total						
Good 2/	6.3	2.0	10.2	5.2	16.5	7.2
Fair	6.4	.9	13.5	2.2	19.9	3.1
Poor	8.3	.6	23.2	2.0	31.5	2.6
Grand Total	21.0	3.5	46.9	9.4	67.9	12.9
Percent Distribution	30.9	27.2	69.1	72.8	100.0	100.0
Average AC/AUM	6.0		5.0		5.3	

1/ Seeded range acreage was combined with good condition grassland in Appendix IV.
2/ Includes seeded range.
Source: Rangeland narrative, C-NP Appendix IV, Subregion 8. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

Table 354 - Sediment Yield from Rangeland, Subregion 8, 1966

Sediment Yield 1/ Categories	Grassland	Shrubs	Total	Percent
	Rangeland Acreage (1,000 Acres)			
Very Low	--	--	--	--
Low	26.5	41.4	67.9	100
Medium	--	--	--	--
High	--	--	--	--
Very High	--	--	--	--
Total	26.5	41.4	67.9	100
	Annual Sediment Yield (Acre-Feet)			
Very Low	--	--	--	--
Low	6	10	16	100
Medium	--	--	--	--
High	--	--	--	--
Very High	--	--	--	--
Total	6	10	16	100

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet, respectively.
Source: Derived from figures 49 and 50.

Measures and Practices for Watershed Protection

Measures applied through 1965 for rangeland watershed improvement are shown on table 355. These have been accomplished in conjunction with similar attention on adjacent farm and timber lands. About 90 percent of the revegetation work was for erosion and water quality control, while brush and weed control was primarily for other management purposes.

Table 355 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Up to 1966, Subregion 8

Measures & Practices	Units	Land Ownership		Total	Watershed Purposes[1]			
		Public[2]	Private		(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	-	700	700	-	x	x	x
Brush Control	Acres	-	1,700	1,700	-	-	x	-
Weed Control	Acres	6	13	19	-	-	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	6	13	19	x	x	x	-
Livestock & Game Water Facilities	Number	-	38	38	-	x	x	-

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Other Land

Other land amounts to 248,600 acres, which is 8 percent of the land area in the subregion. Table 356 shows the acreage of various categories of other land.

Table 356 - Other Land Areas, Subregion 8

	Washington	Oregon	Total	Percent
	-----------1000 Acres---------			
Small Water	25.7	0.5	26.2	10.2
Roads & Railroads	28.0	1.6	29.6	11.4
Farmsteads, Urban, Industrial & Misc.	47.7	2.8	50.5	19.5
Barren Land	149.8	2.5	152.3	58.9
Total	251.2	7.4	258.6	100.0

Source: Appendix IV, Land and Mineral Resources.

Barren land accounts for 59 percent of the other land, and is comprised of rockland, glaciers, and similar areas of sparse vegetation. These areas are valuable for their yield of water and and as open space with scenic and esthetic values.

On the 43 of the 54 watersheds of the subregion there is a shortage of water for municipal, industrial, or rural domestic use, or water quality control.

An estimated 13,000 acres of urban land are subject to flooding at a 10 percent frequency. Nearly all flooding occurs along the lower reaches of the major tributaries of the subregion.

Erosion occurs during construction when vegetative cover is removed and soil is left unprotected. The resulting sediments are frequently more damaging than erosion.

FUTURE NEEDS

The population of the subregion is expected to almost double by 2020. Farm population is projected to decrease to approximately one-third the present number. The projected trends in farm and total population predict a population growth of about 53,000 by 1980, by an additional 72,000 by the year 2000, and by another 92,000 by 2020. The farm population will follow the regional trend in decreasing through the years ahead.

Most significant changes expected in cover and land use include an increase of about 33 percent, or 86,000 acres, in other land, primarily used for urban and industrial expansion. Table 357 shows the projected changes.

Table 357 - Projected Change in Cover and Land Use, Subregion 8

Item	1966	1980	2000	2020
		(1,000 acres)		
Cropland	201.1	176.0	145.0	134.0
Forest Land	2,665.0	2,652.0	2,649.0	2,618.0
Rangeland	67.9	65.0	60.0	60.0
Other Land	258.6	282.0	312.0	344.0
Total	3,192.6	3,175.0	3,166.0	3,156.0

Source: C-NPRBS Projections.

Cropland

The "Present Status" section shows that about 87,700 acres of cropland have a wetness or drainage problem; 9,700 acres have an active erosion problem, and 75,200 acres are subject to frequent flooding. A large percentage of these problems will have to be

corrected if cropland is to meet future needs. Table 358 shows the projected cropland trends.

Table 358 - Projected Trends in Dry and Irrigated Cropland, Subregion 8

Cropland	1966	1980	2000	2020
		(1,000 acres)		
Dry Farmed	183.8	122.0	79.0	36.0
Irrigated[1/]	17.3	54.0	66.0	98.0
Total	201.1	176.0	145.0	134.0

1/ Approximately 97 percent of the projections shown in Appendix IX, Irrigation.
Source: C-NPRBS Projections.

Water Conservation

Irrigation was not extensively practiced until after the mid-1940's. Although a few cranberry bogs were flood irrigated, irrigation was not popular until sprinkler irrigation began to be used.

Agricultural production must double by 2020 in order for the subregion to maintain its present position in relation to population. Most of the subregion's increased production is expected to be met by adding irrigation. A major need in this subregion is to increase the use of supplemental irrigation to stabilize yields and to meet the goals for food and fiber. Table 359 shows the projected needs that will be met for increased irrigation under the most efficient application.

Table 359 - Projected Cumulative Trend in the Method of Irrigation on Cropland, Subregion 8

Item	1966	1980	2000	2020
		(1,000 acres)		
Sprinkler Irrigation Systems	17	38	66	98

Source: Soil Conservation Service, C-NPRBS Projections.

Drainage

There are 87,700 acres of cropland with an excessive wetness problem. Approximately 16,000 acres of this area have already been drained. Irrigation expansion is expected to increase the areas of excessive wetness by an additional 4,000 acres. Most of this area will need to be drained to meet production needs (table 360).

Table 360 - Cumulative Cropland Areas Needing Drainage, Subregion 8

Item	1966	1980	2000	2020
		(1,000 acres)		
Wet Areas	88	89	91	92
Projected Accomplishments	16	32	57	82
Remaining	72	57	34	10

Source: Soil Conservation Service, C-NPRBS Projections.

Erosion and Sedimentation

There are 9,700 acres of cropland that have an active erosion problem. Erosion is a major limitation on approximately 61,800 acres of cropland. Increased control of erosion is necessary to meet future needs (table 361).

Table 361 - Cumulative Cropland Areas Needing Erosion Control Subregion 8

Item	1966	1980	2000	2020
		(1,000 acres)		
Erosion Potential	62	57	50	43
Projected Accomplishment	52	52	47	42
Remaining Problem	10	5	3	1

Source: Soil Conservation Service, C-NPRBS Projections.

Rock riprap prevents bank erosion during high water flows. (SCS W-2210-10)

Flooding

There are 75,200 acres of cropland needing flood protection approximately one year in ten. Continuing flood protection is essential to meet future needs. Flood protection in some areas requires costly expenditures for structures and special practices. Many of these await development of pressure for more crops with more intensive land use. Control or prevention of floods probably will not be economically feasible; however, protection needs to be extended.

Forest Land

The forest-based industries of the subregion will require about 834 million cubic feet of raw material per year by the year 2020. This volume will be produced principally on the 2.4 million acres of commercial forest land, which is projected to remain in production by the year 2020. This can be expressed as a future need for 350 cubic feet of raw wood per acre. Compared to the present industrial consumptive rate of 220 cubic feet per acre of commercial forest land and to the present growth rate of 105 cubic feet per acre, a need for timber yields improvement is apparent. Much of the present industrial consumption is imported from other areas. However, future increases may not be met in this way as neighboring subregions are also experiencing or will experience needs exceeding present forest land capabilities.

Improved forest management techniques are necessary, including improved regeneration, fertilization, thinning, release, and the use of selective tree breeding. More complete utilization of existing raw material is also necessary. Where small private

woodlands are involved, the technical services of the state's farm foresters and Soil Conservation Service foresters will be highly essential.

Potential sediment yields and erosion hazards have been estimated for the forest lands of the subregion. They are summarized on table 362 and figure 50. These data represent potential yields prior to the establishment of protective or rehabilitative measures and could exceed present by nearly 5 times.

Table 362 - Potential Sediment Yield without Protective Measures, Forest Land, Subregion 8

Soil Loss Category	Acres (1,000)	Percent	Acre-feet per Square Mile per Year	Total Acre-feet per Year
Low	213.1	8	Less than 0.2	33
Medium	1,907.2	72	0.2 - 1.5	596
High	544.7	20	More than 1.5	1,277
Total	2,665.0	100		1,906

Source: Soil Survey Data & Interpretations, U.S.D.A. Forest Service, Region 6.

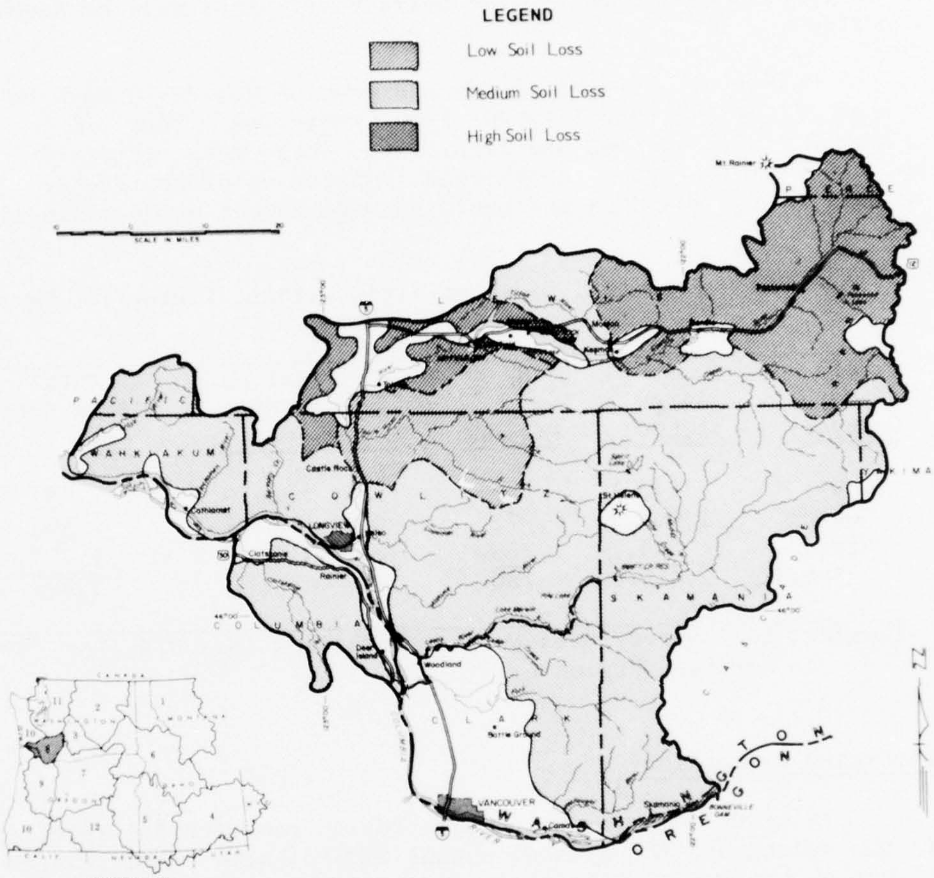
Watershed Protection

In order to help meet the increased raw material requirements in the subregion, the present annual timber harvest and road construction program will continue or accelerate--at least until the ultimate road system is complete. Table 363 lists this as a cumulative future program to meet these demands. Also included is the estimated acreage of ground disturbed during these operations that will require watershed protection practices such as seeding, mulching and restoring a protective ground cover.

Table 363 - Projected Cumulative Timber Harvest Activity Forest Land, Subregion 8 1/

	Unit	1980	2000	2020
Timber Harvest Area	Acres	532,000	1,232,000	1,932,000
Road Construction	Miles	3,700	8,600	13,500
Ground Disturbance 2/	Acres	64,000	148,000	232,000

1/ Based on the 1965 level of timber requirements.
2/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.



COLUMBIA - NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

POTENTIAL EROSION HAZARD FOREST LAND

LOWER COLUMBIA, SUBREGION 8

1968

FIGURE 51

USDA-SCS-PORTLAND, OREG. 1969

By the year 2020, nearly 250,000 acres of forest land will have had the ground cover severely disturbed by timber harvest and road construction. This area will require stabilization as cover loss occurs since the highest levels of sediment yield will originate here unless protection is provided. With nearly 2 million acres under harvest by 2020, watershed protection measures and improved technical assistance for private land owners need acceleration accordingly.

Watershed Rehabilitation

The critical areas requiring cover rehabilitation are scattered throughout the subregion. They amount to some 20,000 acres, according to present inventories. Another serious problem is the blockage of anadromous fish from spawning areas by natural causes, both from landslides and timber blowdowns. A typical logjam caused by blowdown on a fish spawning tributary in the subregion is pictured below. Removal of this type of debris constitutes a major job in this area, and its completion opens many miles of spawning streams.

Debris dams block many miles of anadromous fish spawning streams in the subregion. This type of damage is usually the result of severe winter storms. (Forest Service)

Water Yield Improvement

The Water Retention Capacity Map (figure 52) and table 364 indicate the ground-water storage capacity represents about 20 percent of present streamflows. There is the possibility of developing this potential by water yield improvement practices but none are planned at this time.

Table 364 - Water Retention Capacity, Forest Soils, Subregion 8

Retention Class	Acres (1,000)	Percent	Acre-feet per Square Mile	Total Acre-feet
Low	1,199.4	45	Less than 300	562,000
Medium	1,465.6	55	300 - 1,500	2,061,000
High	--	--	More than 1,500	--
Total	2,665.0	100	.	2,623,000

Source: Soil Survey Data & Interpretations, U.S.D.A. Forest Service, Region 6.

Rangeland

Heavy precipitation and relatively high runoff in the winter and spring cause erosion of some range parcels where cover has been severely disturbed. Drainage problems exist on certain low lying areas, and excessive runoff through rangeland tracts causes flood damage to downstream crop and urban areas.

Projected Use of Range Resources

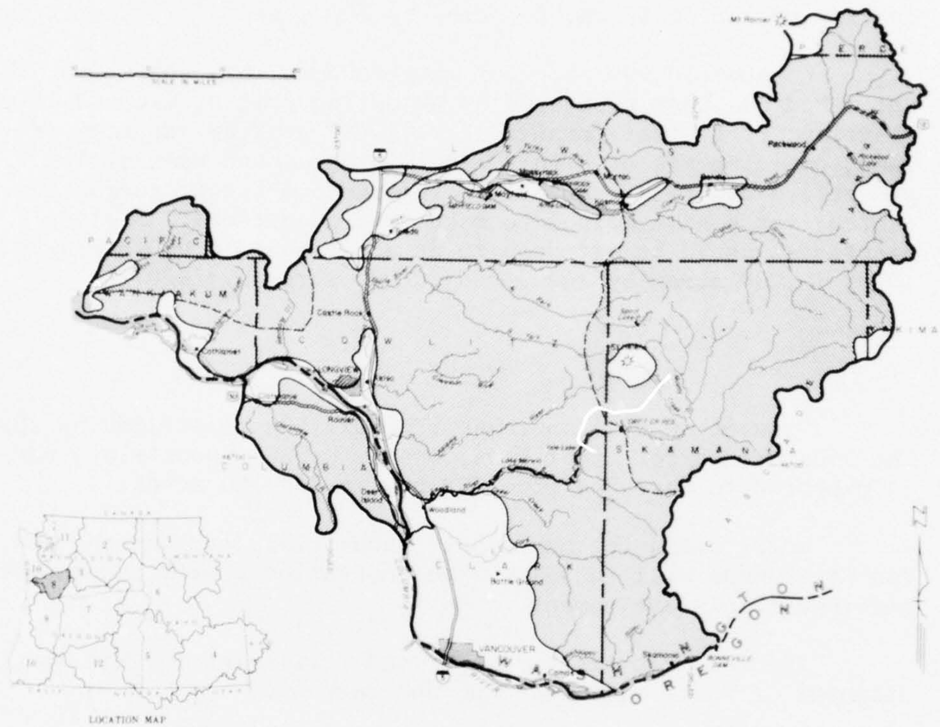
Rangeland will continue to be a relatively small segment of the land area, and will be subject to continued shifts in use. It is expected to decrease from 68,000 acres in 1966 to about 60,000 acres by 2020. Some present cropland may revert to rangeland throughout this 50-year period, while rangeland near population centers will be converted to urban and "other" land uses. Other rangeland adjoining developed agricultural areas will be used for cropland, and some areas will be restored to tree cover for Christmas tree or timber production. ( )

Watershed Needs

Since the base rangeland use is unstable, long-term range management is unpredictable. Range watershed condition will

LEGEND

LOW	LESS THAN 300 AC. FT. PER SQ. MI. PER YEAR
MEDIUM	300-1,500 AC. FT. PER SQ. MI. PER YEAR
HIGH	MORE THAN 1,500 AC. FT. PER SQ. MI. PER YEAR



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER RETENTION CAPACITY FOREST LAND

LOWER COLUMBIA, SUBREGION 8

1968

FIGURE 52

continue to be largely dependent on the management of adjoining cropland and forest land. An estimated 2,400 acres of rangeland had received land treatment by 1966 for erosion and sedimentation control with accompanying benefits for flood control and drainage. An additional 6,500 acres will require treatment by 1980 to prevent excessive erosion and sedimentation and to improve water retention quality of the soils, 23,600 acres by 2000, and 37,200 acres by 2020.

On some 30,000 acres of rangeland in this subregion, the watershed has been protected by adjusting grazing use and livestock distribution to that compatible with the grazing capacity of the land, avoiding use of highly erodible areas and maintaining protective vegetative cover. Development of water facilities and control fence have helped to make this adjustment. Similar practices should be extended to an additional 10,000 acres by 1980, 15,000 acres by 2000, and 20,000 acres by 2020.

Other Land

Population will increase from 224,500 to 441,300 by 2020. The land needed for other uses, mostly urban, industrial, and roads is expected to increase from 258,600 to 344,100 acres.

Water needs for municipal, industrial, irrigation, and rural domestic needs will increase with population growth and commercial and industrial development.

The requirements for water and facilities for the sanitary disposal of waste will continue and increase.

Flood protection is needed for expanding urban and industrial areas. There is a need for adequate floodwater disposal systems in the upland development areas to prevent flooding.

The need for erosion control will continue and increase. Control measures are needed to reduce soil loss and sediment damage to reservoirs, streams, and drainage facilities.

MEANS TO SATISFY NEEDS

Alternate ways of satisfying future demands for water, drainage, erosion control, and flood protection are discussed in this section. Although most of the discussion is devoted to problems and solutions by target dates 1980, 2000, and 2020, the problems beyond this period are also presented.

Land management practices that conserve soils also reduce flood damages. Soil conservation practices retard flows and increase

the intake and storage of water by the soils. Reductions of soil erosion also reduce the quantity of sedimentation. A combination of improved management practices, land treatment measures, and water control structures will be necessary to satisfy future needs.

A survey of conservation needs of the subregion was made as a part of this study. The study revealed that 44 of the 48 watersheds required accelerated planning and development to meet projected needs. Planning requirements for development of these watersheds are shown in table 365 and figure 53.

Table 365 - Practices Required for Cooperative Conservation Development, Subregion 8

Target Date and State	Watersheds	Flood Protection	Erosion Control	Drainage	Irrigation: New	Irrigation: Supplemental	Land Treatment
		(1,000 acres)					
1980							
Washington	24	38.9	3.3	45.5	51.2	0.5	87.7
Oregon	-	-	-	-	-	-	-
Total	24	38.9	3.3	45.5	51.2	0.5	87.7
No. Watersheds		(24) 1/	(21)	(24)	(20)	(2)	(23)
2000							
Washington	10	30.7	5.7	31.1	32.6	0.1	67.8
Oregon	3	3.5	0.4	9.1	12.4	0.8	13.0
Total	13	34.2	6.1	40.2	45.0	0.9	80.8
No. Watersheds		(13)	(13)	(13)	(12)	(1)	(13)
2020							
Washington	7	2.1	0.3	2.0	7.8	-	4.1
Oregon	-	-	-	-	-	-	-
Total	7	2.1	0.3	2.0	7.8	-	4.1
No. Watersheds		(1)	(3)	(3)	(5)	(0)	(5)

1/ Number of watersheds involved in each function by time periods.
Source: Soil Conservation Service, C-NPRBS Projections.

Cropland

Cropland is projected to decrease from 21,100 acres in 1966 to 137,400 acres by 2020. Acreage yields are expected to increase as they have in the past. This has been due to improved management, fertilization, and conservation practices. Yields may be further increased by irrigation, drainage, erosion control, and flood protection. Total land area suitable for crop production is shown in table 366.

COLUMBIA-NORTH PACIFIC

COMPREHENSIVE FRAMEWORK STUDY

AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

LOWER COLUMBIA, SUBREGION 8

1968

FIGURE 53

Table 366 - Land Areas Suitable for Crop Production, Subregion 8, 1966

Capability Class 1/	Washington	Oregon	Total	Percent
		(1,000 acres)		
I	11.6	-	11.6	1
II	200.3	16.7	217.0	19
III	364.0	70.7	434.7	39
IV	413.1	53.6	466.7	41
Total	989.0	141.0	1,130.0	100

1/ Discussed, Appendix IV, Land and Mineral Resources.
Source: Soil Conservation Service, C-NPRBS Data.

Water Conservation

Irrigation is expected to increase from 17,300 acres in 1966 to 98,000 acres by 2020. Sprinkling will continue to be the method of applying irrigation water. Table 367 shows the projected practices for irrigated cropland that will contribute to meeting the needs for food and fiber.

Table 367 - Cumulative Projected Practices for Irrigated Cropland, Subregion 8

Practice	Units	1966	1980	2000	2020
Water Control Facilities	No.	717	1050	1500	2000
Irrigation Water Conveyance	Miles	9	10	15	25
Water Storage	No.	12	13	14	18
Irrigation System, Sprinkler	No.	504	700	1050	1400
Land Shaping	1000 Acs.	2	3	3	4
Irrigation Water Management	1000 Acs.	10	21	50	80

Source: Soil Conservation Service, C-NPRBS Projections.

Irrigation is considered to be a marginal investment by many farmers. Some years are cool and damp, requiring little irrigation. The average crop irrigation requirement is figured to be 16 inches. However, to stabilize yield and make efficient use of fertilizers and soil amendments, supplemental irrigation is required. Also, the diversification of crops is economically more feasible with irrigation. Livestock growers are expected to increase irrigation to insure maximum carrying capacity on their pastures.

Drainage

More than 87,700 acres of cropland have excessive wetness, limiting general crop production. Total cropland is projected to decrease to 68 percent of the present acreage. Wet cropland is expected to increase 5 percent to about 92,000 acres. Table 368 shows the projected practices that will contribute most toward adequate drainage of wet areas.

Table 368 - Cumulative Drainage Practices Required to Provide Needed Drainage, Subregion 8

Practice	Unit	1966	1980	2000	2020
Conduits and Ditches	miles	863	1,400	2,000	2,760
Structures	number	401	550	775	1,000

Source: Soil Conservation Service, C-NPRBS Projections.

Some 16,000 acres had been drained by 1966. By 2020, drainage practices should be applied on a total of about 82,000 acres to meet projected cropland requirements.

Open drainage canals and laterals are common practices for removing excess water in this subregion. (SCS F-99-12)

Areas with high water tables are extensive in the winter months. Many of the areas are still wet at the beginning of the growing season, and only water-tolerant grasses can be grown. Drainage will increase the growing season and permit the use of more productive crops. Most of the wet areas can be drained to such a degree that wetness is not a problem during a 4- to 5-month growing season.

Drainage of wet soils will continue to be done by individuals and by drainage or diking districts. Expenditures of public funds will occur as cost sharing and technical assistance.

Erosion and Sedimentation

There are 9,700 acres of cropland that are currently eroding at an excessive rate. Most of the acreage will be treated by individual landowners with cost sharing and technical assistance from public funds.

Most of the erosion occurs during winter months. The increase in irrigation is expected to aid in erosion control by insuring the establishment of a winter cover crop. Water can be applied to give the soil optimum moisture for seedbed preparation and the establishment of the cover crop.

Erosion of cropland will be further reduced according to the projected needs for cropland. Cropland acreage is projected to decrease 32 percent by 2020. The present use of 62,000 acres, with erosion as the major use limitation, is projected to decrease to 43,000 acres.

Table 369 shows the practices needed to treat those areas with an active erosion problem, as well as maintain other areas in a stable condition.

The practices listed in table 369 serve to reduce the impact of rain and the velocity of runoff water from cropland.

Table 369 - Cumulative Practices to Satisfy Erosion Control Needs, Subregion 8

Practice	Unit	1966	1980	2000	2020
Grade Stabilization Structures	No.	21	40	55	70
Diversions & Terraces	Miles	2	22	50	80
Ditch Bank Seeding	Miles	196	250	375	500
Crop Residue Use	1,000 Acs.	24	28	35	43
Grassed Waterway	Acres	16	60	130	200
Conservation Cropping System	1,000 Acs.	121	129	137	146
Pasture and Hayland Planting	1,000 Acs.	50	55	59	63

Source: Soil Conservation Service, C-NPRBS Data.

Flooding

More than 75,000 acres of cropland are subject to flooding one year in 10. There is need for more diking, improved dikes and tide gates, and pumping plants. Most of the flood prevention work will be done by individuals and diking districts. Public funds will be used for cost sharing and technical assistance. The detention of floodflows will be mostly from public funds. Table 370 shows some of the needed flood prevention work.

Table 370 - Cropland Flood Prevention Practices, Subregion 8

Practice	Unit	1966	1980	2000	2020
Stream Channel Improvement	Miles	59	60	64	65
Streambank Protection	Miles	119	290	500	710
Stream Channel Stabilization	Miles	13	15	30	50
Dikes and Levees	Miles	128	135	170	200

Source: Soil Conservation Service, C-NPRBS Data.

Drainage ditches and protective dikes are used extensively along the Columbia River. (SCS WN-8500-2)

Program Costs

The costs of implementing conservation practices discussed in the previous sections are given in table 371, and are based on 1969 dollars.

Table 371 - Cumulative Cost of Cropland Conservation Practices, Subregion 8

Item	Water Conservation	Drainage	Erosion Control	Flood Control	Total
	1000 Dollars				
1966-1980					
Private Funds	12,758	2,855	3,864	1,000	20,477
Public Funds	682	2,103	2,576	2,000	7,361
Total	13,440	4,958	6,440	3,000	27,838
1981-2000					
Private Funds	33,641	5,394	4,944	1,500	45,479
Public Funds	1,799	3,973	3,296	3,000	12,068
Total	35,440	9,367	8,240	4,500	57,547
2001-2020					
Private Funds	54,145	5,766	4,146	2,000	66,057
Public Funds	2,895	4,247	2,764	4,000	13,906
Total	57,040	10,013	6,910	6,000	79,963

Source: Soil Conservation Service, C-NPRBS Data.

Forest Land

Increasing demands for forest products will cause mounting pressures for more timber production on forest lands of the subregion. This in turn, will require increasing levels of watershed protection to maintain the present watersheds in a good hydrologic condition. Structural and nonstructural means to accomplish this objective are presented in this section.

Watershed Protection

It is anticipated that watershed protection practices will parallel the rise in timber harvest activities as outlined in table 351. This increasing level should be maintained on the public forest lands, particularly on those areas outlined in figure 51, the Potential Erosion Hazard Map, as being in the more critical areas. To maintain present water quality, watershed protection practices on the private forest lands must be accelerated to the level that presently exists on the public lands. Table 372 outlines the required land measures and total cost of such measures, accumulated through the year 2020. These costs are based on the assumption that: (1) On the public forest lands, controls through timber sale and construction contracts are adequate if properly applied, and (2) on the private forest lands, the minimum level required by 2020 will at least equal that presently accomplished on the public lands.

Table 372 - Projected Costs for Watershed Protection Practices, Forest Land, Subregion 8

Practice	Unit	Total Units1/	Total Cost1/ ($1,000)
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	28,000	840
Harvest Road Treatment2/	Mi.	3,900	975
Other Watershed Requirements3/	Ac.	1,166,000	37,281
Total Cost			39,096
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	69,000	1,725
Harvest Road Treatment	Mi.	9,600	1,920
Other Watershed Requirements	Ac.	1,465,000	53,020
Total Cost			56,665
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	97,000	2,565
Harvest Road Treatment	Mi.	13,500	2,895
Other Watershed Requirements	Ac.	2,631,000	90,301
Total Cost			95,761

1/ Total for 55-year period 1965-1920. Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, timber cultural practices, and other indirectly related items.

At the rate projected in table 372, recurrent watershed protection measures will cost about $710,000 annually on public forest lands and should cost $1,030,000 annually on the private.

Converting to total costs, this amounts to $95,761,000. This represents the cost of maintaining the productive condition of the forest watersheds under the pressure of the projected demands.

Watershed Rehabilitation

The forest lands in need of rehabilitation are scattered throughout the entire forest area, mostly within the low sediment yield zone as listed on table 350. Table 373 lists these acreages and the amount that should be treated during time periods 1980, 2000, and 2020. Table 374 outlines the expected sediment reduction through application of these measures.

Table 373 - Projected Watershed Rehabilitation Programs, Forest Land, Subregion 8

Program	Unit	1980 Amount	1980 Cost 1/ ($1,000)	2000 Amount	2000 Cost 1/ ($1,000)	2020 Amount	2020 Cost 1/ ($1,000)
FEDERAL LANDS							
Land Treatment	Ac.	200	64	150	48	100	32
Stream Rehabilitation	Mi.	100	281	150	422	160	450
Road Rehabilitation	Mi.	90	46	120	61	120	61
Total Cost			391		531		543
NONFEDERAL LANDS							
Land Treatment 2/	Ac.	6,050	484	7,050	564	7,050	564
Stream Rehabilitation	Mi.	70	350	100	500	110	550
Road Rehabilitation	Mi.	125	7	160	8	160	8
Total Cost			841		1,072		1,122
TOTAL ALL LANDS							
Land Treatment	Ac.	6,250	548	7,200	612	7,150	596
Stream Rehabilitation	Mi.	170	631	250	922	270	1,000
Road Rehabilitation	Mi.	215	53	280	69	280	69
Total Cost			1,232		1,603		1,665

1/ In 1969 dollars.
2/ SCS River Basin Survey Data.

The overall expected sediment reduction is about 6 acre-feet per year. Although this gives a low subregional average, it reflects the work needed on the critical areas. This will undoubtedly have a more significant effect in localized areas, particularly in the case of stream clearance and streambank protection. This is of major importance to the protection of anadromous fish spawning areas, one of the major stream resources of the subregion.

Table 374 - Expected Annual Sediment Reduction
Forest Land Rehabilitation, Subregion 8

Present Yields 1/	Acres (1,000)	Total Sed. Yield Ac-ft./Yr.	Acres Treated 2/	Sediment Reduction Ac-ft./Yr.
Very low	--	--	--	--
Low	2,626.0	411	45,000	5.6
Medium	39.0	12	--	--
High	--	--	--	--
Very High	--	--	--	--
Total	2,665.0	423		5.6
			Total reduction, percent	1

1/ Data from table 350.
2/ Data from table 373. Miles treated converted to acres.

In addition to the needs for sediment reduction on the presently eroding forest lands, nonrecurrent work will be required on any future large and extensive forest burns and on lands directly related to future water storage projects. These sediment sources will be treated as they occur. Hence, the 1 percent is the current amount of reduction should no new sources occur through catastrophic fire or other natural disaster.

Water Yield Improvement

No water yield improvement programs are presently planned for the subregion. Present and foreseeable water demands can be met by existing streamflows augmented by storage projects. Snowfield management holds the most promise should additional needs arise.

Total Program Costs

In summary, the total cost of forest watershed protection and land treatment programs through the year 2020 may be expressed as follows:

	Costs ($1,000)
Watershed Protection	95,761
Watershed Rehabilitation	4,500
Water Yield Improvement	None

Rangeland

Measures and Practices for Watershed Protection

Watershed practices to satisfy future needs for range protection and improvement are shown on table 375. Most of these practices also have other management objectives or purposes.

Between 1966 and 2020, cover improvement and soil stabilization practices will be required on about 35,000 acres of rangeland, including recurring efforts on some of the same acreages and multiple practices on certain areas. An estimated 120 miles of livestock control fences need to be constructed, reconstructed, or repaired, and an additional 90 livestock and game water facilities are necessary. About 10 percent of the requirements will be for

Table 375 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 2020, Subregion 8

Measures & Practices by Time Periods	Units	Land Ownership: Public 2/	Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
1966 to 1980								
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	2	4	6	-	-	x	x
Brush Control	Acres	60	130	190	-	-	x	-
Weed Control	Acres	5,900	13,000	18,900	-	-	x	-
Contouring, Pitting, Furrowing	Acres	200	500	700	-	x	x	x
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	15	25	40	x	x	x	-
Livestock & Game Water Facilities	Number	6	13	19	-	x	x	-
1981 to 2000								
Cover Improvement & Soil Stabilization								
Brush Control	Acres	100	300	400	-	-	x	-
Weed Control	Acres	11,700	26,000	37,700	-	-	x	-
Contouring, Pitting, Furrowing	Acres	600	13,000	13,600	-	x	x	x
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	15	25	40	x	x	x	-
Livestock & Game Water Facilities	Number	10	20	30	-	x	x	-
2001 to 2020								
Cover Improvement & Soil Stabilization								
Brush Control	Acres	100	300	400	-	-	x	-
Weed Control	Acres	11,700	26,000	37,700	-	-	x	-
Contouring, Pitting, Furrowing	Acres	900	2,100	3,000	-	x	x	x
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	15	25	40	x	x	x	-
Livestock & Game Water Facilities	Number	15	25	40	-	x	x	-

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

erosion and water quality control, 10 percent for water conservation, and 5 percent for drainage. Numerous small size parcels of rangeland and continual shifts in grazing lands use require a relatively large number of water facilities and mileage of fence. Many of the areas on which these practices are accomplished may revert to other types of use by 2020.

Erosion and Sediment Yield Improvement

It is anticipated that the practices listed on table 375 for erosion and water quality control will be applied on some of the small eroded areas of higher sediment yield. Yet, other areas will receive inadequate attention to erosion and sediment problems created by the shift of land use and ownership changes. Rangeland sediment yield is expected to decrease from 16 acre-feet in 1966 to 14 acre-feet by 2020 (table 376).

Table 378 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Subregion 8 1/

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
		Public Land		
Cover Improvement and Soil Stabilization	3.0	7.4	6.6	17.0
Watershed Oriented Land Management Practices	3.0	3.0	3.7	9.7
Water Control Structures	--	--	--	--
Total	6.0	10.4	10.3	26.7
		Private Land		
Cover Improvement and Soil Stabilization	7.1	100.4	15.5	123.0
Watershed Oriented Land Management Practices	5.0	5.0	6.3	16.3
Water Control Structures	--	--	--	--
Total	12.1	105.4	21.8	139.3
		Total		
Cover Improvement and Soil Stabilization	10.1	107.8	22.1	140.0
Watershed Oriented Land Management Practices	8.0	8.0	10.0	26.0
Water Control Structures	--	--	--	--
Total	18.1	115.8	32.1	166.0

1/ Based on measures and practices shown on table 435 with constant 1969 dollars.

Other Land

Coordinated planning by all levels of government and private interests can best accomplish the needs for natural resource development. Planning should encompass flood protection, drainage, water needs, recreation, fish and wildlife, and esthetic values.

Farming is the principal use of land adjoining many urban developments. Urban interests can best be served by including the agricultural industry in planning for other uses of land. Consideration should include the esthetic values of open space and its recreational value, including hunting.

Flood protection for other land that is presently flooded can be enhanced by flood detention reservoirs, enlarged or improved channels, and by dikes and levees. Land treatment measures on adjacent or upstream cropland, forest land, and rangeland are essential to reduce flooding and debris damage to developed areas

and to prevent the pollution of water by sediment. During urban construction, debris basins can be provided to prevent silt and debris from leaving the construction site.

Soil surveys and interpretive maps will provide a basis for a more economical expansion of urban land uses. These soil surveys indicate the hazards of use for certain developments on the watershed and possible ways to overcome or alleviate the problems.

LOCATION MAP

SUBREGION 9

S U B R E G I O N 9
W I L L A M E T T E

PRESENT STATUS

Subregion 9, the Willamette, lies between the Cascade and Coast Ranges and is entirely within the State of Oregon. It covers 7.7 million acres and accounts for about 4.5 percent of the region. Land area in the subregion contains 7.6 million acres and large water bodies total 106,000 acres. With 22 percent of the region's population, it is the second most populous of the 12 subregions. About 57 percent is private land and 43 percent is public. The largest public holding is national forest, followed by Bureau of Land Management and state-owned timber lands.

The subregion has a temperate, maritime climate characterized by wet winters and dry summers. Relatively high annual precipitation occurs on the Coast and Cascade Ranges, with over 200 inches and 150 inches respectively. The valley lands are in the rain shadow of the Coast Range and receive much less precipitation; the average is between 35 to 50 inches. Precipitation is seasonal. Approximately 25 percent occurs in the fall, 45 percent in the winter, 25 percent in the spring, and only 5 percent in the summer.

Total annual stream discharge amounts to 28.2 million acre-feet. Nearly 80 percent comes from forested areas, the balance from crop and pasturelands (figure 54).

Sediment yields vary by type of land use. Principal sources are the cultivated areas in the valley bottoms and foothills and active logging areas in the forested uplands.

Table 379 - Generalized Sediment Yield by Cover and Land Use, Subregion 9

Cover and Land Use	1,000 Acres 1/	Percent	Sediment Yield Ac.Ft./Year	Percent
Cropland	1,456.1	19	706	38
Forest Land	5,272.0	69	840	45
Rangeland	58.8	1	14	1
Other Land	815.9	11	297	16
Total	7,602.8	100	1,857	100

1/ Based upon Willamette type 2 study data adjusted to C-NP definitions
Source: Derived from figures 55 and 56 and Appendix IV.

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

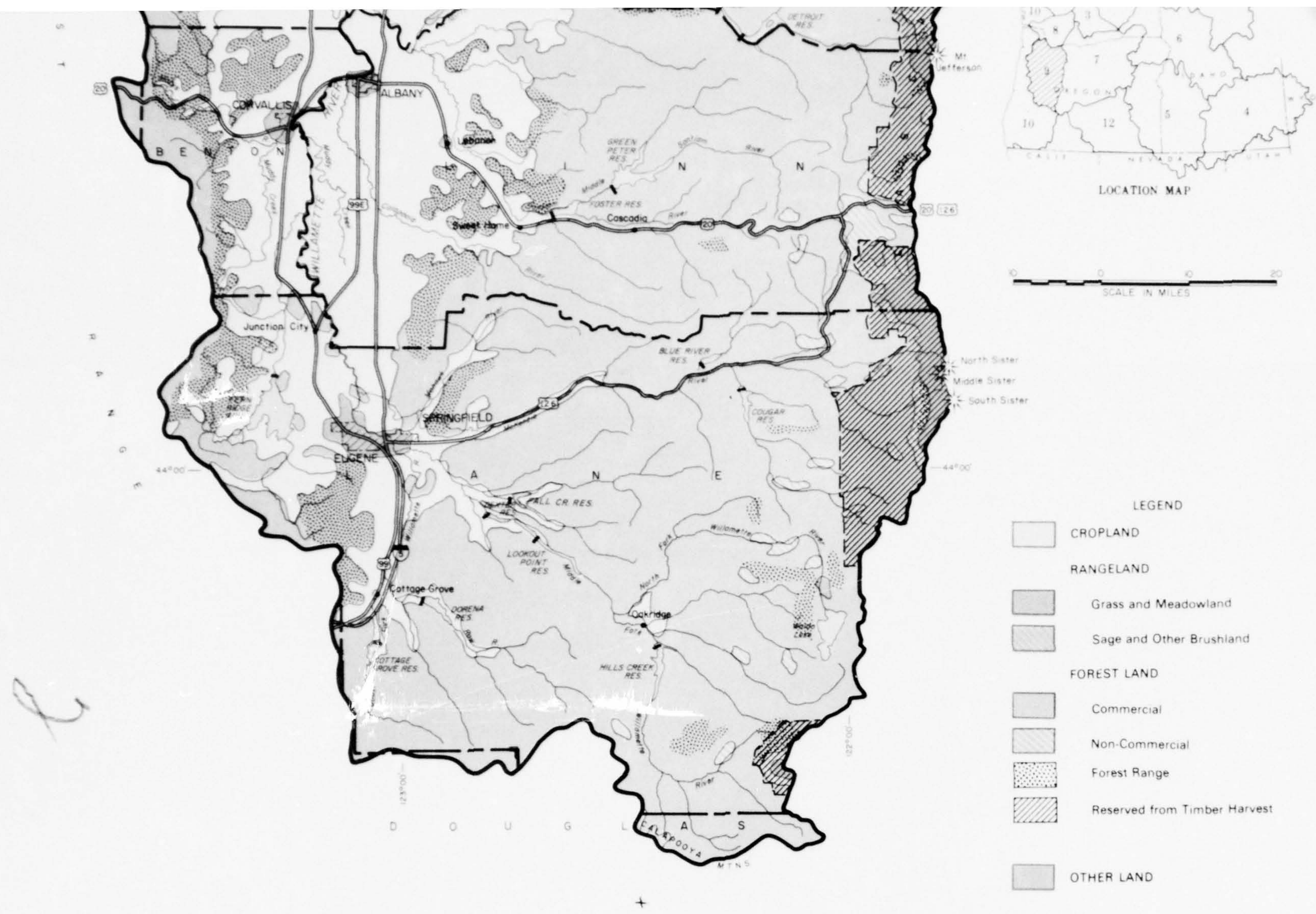
MEAN ANNUAL RUNOFF IN INCHES

WILLAMETTE SUBREGION 9

1968

FIGURE 54

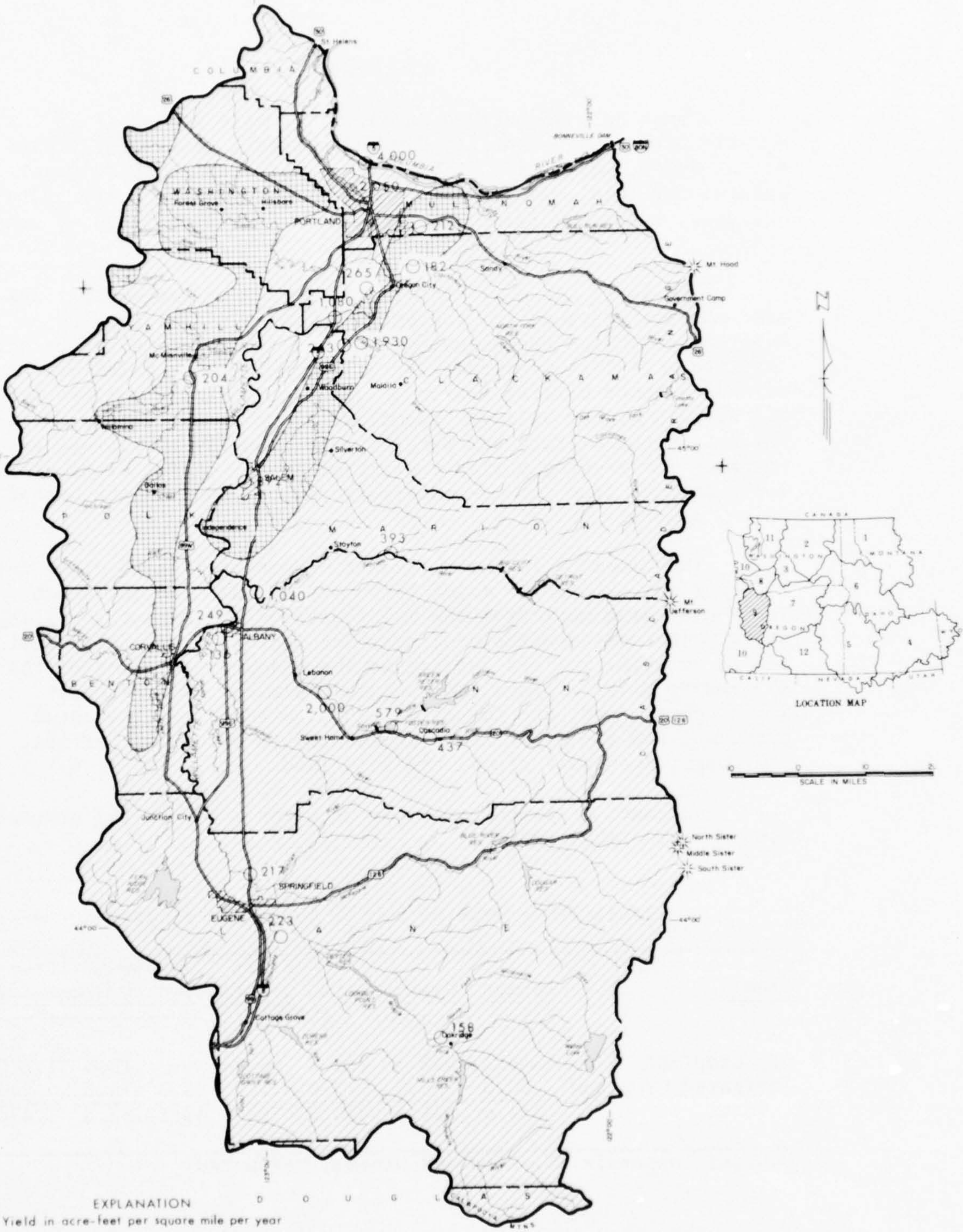

WASHINGTON
OREGON
COLUMBIA
WASHINGTON
MULTNOMAH
CLACKAMAS
YAMHILL
POLK
MARION
BENTON
LINN
COAST
St Helens
Forest Grove
Hillsboro
PORTLAND
Oregon City
Sandy
Mt. Hood
Government Camp
BONNEVILLE DAM
BULL RUN RES.
McMinnville
Woodburn
Molalla
Timothy Lake
Willamina
Silverton
SALEM
Dallas
Independence
Stayton
BIG CLIFF RES.
DETROIT RES.
Mt Jefferson
CORVALLIS
ALBANY
Lebanon
GREEN PETER RES.
FOSTER RES.
Sweet Home
Cascadia
Junction City
BLUE RIVER RES.
SPRINGFIELD
EUGENE
COUGAR RES.
North Sister
Middle Sister
South Sister
45°00'
WILLAMETTE
LOCATION MAP
CANADA
MONTANA
WASHINGTON
OREGON
IDAHO
CALIF.
NEVADA
UTAH
SCALE IN MILES



COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED
COVER AND LAND USE
WILLAMETTE, SUBREGION 9
1968

FIGURE 55



EXPLANATION

Yield in acre-feet per square mile per year

- 0.02 – 0.1
- 0.1 – 0.2
- 0.2 – 0.5
- 0.5 – 1.5
- 1.5 – 4.0

○ 2,780 Highest observed concentration in mg/l

COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

WILLAMETTE SUBREGION 9

1968

FIGURE 56

Cropland

Crops have been grown in the Willamette Valley since shortly after the Hudson Bay Company established a trading post at Vancouver, Washington. The first crops were grown in small gardens for local consumption. From this beginning agriculture has grown to 21,990 farms and includes 1.5 million acres of cropland.

The basin has a climate characterized by wet winters and dry summers. Because the subregion is largely dominated by maritime air, both the annual and diurnal temperature ranges are relatively small. Croplands in the subregion have relatively long periods without killing frosts of 250 days in lower valleys and 160 days in higher valleys. Cropland soils in the valley, predominately sedimentary and ranging from gravelly to clayey, are suitable for growing a wide variety of crops. A few areas of soils derived from igneous materials can be found in the Chehalem, Salem, and Eola Hills.

The cropland in the Willamette Basin is located along the valley floor, along the major tributary streams, on the bench lands extending back from the major streams, through the rolling hills which dominate the area near the foothills of the mountains, and in stringer valleys leading to the major tributaries of the Willamette River (figure 55). Closely planted crops such as grain, grass seed, and forage make up two-thirds of the total cropland, and the other third is devoted to orchards, berries, row crops, specialty crops, and idle land.

Acreages of principal types of crops grown in the subregion are shown in table 380.

Table 380 - Type of Crops, Subregion 9, 1966

Item	Forage	Grain	Seed	Fruit & Nuts	Row Crops	Specialty & Other	Total
	1000 Acres						
Dry Cropland	344.1	528.1	269.2	60.7	--	10.0	1.212.1
Irrigated Cropland	90.5	6.9	7.0	15.7	48.1	75.8	244.0
Total	434.6	535.0	276.2	76.4	48.1	85.8	1.456.1

Source: Appendix IV, Land and Mineral Resources

The subregion leads the country in production of such seed crops as Merion bluegrass, chewing fescue, red fescue, bentgrass,

crimson clover, common ryegrass, and perennial ryegrass. The production of certified seed of many other seed crops is also high.

Although the total acreage of row crops and specialty crops is not large (133,900 acres), their contribution to the economy is of major importance. Because nearly all of these crops are sold in a processed form, Oregon ranks fifth nationally in the value of frozen and canned fruits and vegetables. About 24 percent of the United States' processed snap bean supply comes from the Willamette Valley as does 11 percent of the sweet corn. Nut crops, such as filberts, are grown almost exclusively in the subregion.

Water Conservation

Water conservation problems result from such factors as the seasonal distribution of precipitation, the water holding capacity of soils, the choice of crops, and the climate. Where winter and spring runoff is not stored in reservoirs, streamflows are drastically reduced during the growing season. A number of practices have been effective in overcoming these problems (table 381).

Table 381 - Water Conservation Practices Applied on Cropland, Subregion 9, 1966

Practice	Units	Amount
Water Control Facilities	No.	57
Water Storage Facilities	No.	1,033
Irrigation Water Conveyance Facilities	Miles	36
Irrigation System, Sprinkler	No.	3,185
Land Shaping	Acres	39,500
Irrigation Water Management	Acres	139,500

Source: USDA Soil Conservation Service Data

Historically, irrigation has been supplemental rather than necessary for most crops. The climate is favorable to a diversified agriculture without irrigation; however, the trend is toward specialization and intensification. Irrigation is important for production of high quality and quantity of most vegetables and berries. Food processors are requiring growers to be able to irrigate before a contract is negotiated.

The estimated 244,000 acres of irrigated cropland in 1966 are 17 percent of all cropland. About 37 percent of all irrigated land is devoted to forage crops for livestock production; vegetables,

berries, fruit and nuts account for 26 percent; and the remaining 37 percent was used for a variety of crops primarily in the specialty category. Table 382 shows the source of the irrigation water, supply adequacy, and method of application.

Table 382 - Water Availability and Irrigation Methods For Cropland, Subregion 9, 1966

Water Source	Total 1000 Acres
Streamflow	117.2
Ground water	100.0
Storage	26.8
Total	244.0
Area with adequate supply	223.4
Area with inadequate supply	20.6
Method of application	
Sprinkler	240.1
Flooding	3.9

Source: USDA River Basin Data

At the present time, the total water supply is not a limiting factor to irrigation development. Although the summer flows in the major streams are low, the volume is still adequate for present overall demands. In local areas there is some problem in obtaining adequate supply at the proper time and place desired.

Drainage

About 807,000 acres of land in capability class II to IV, including 420,000 acres of cropland, have an excessive wetness problem. It is created by either a high water table, internal soil restrictions, or flooding and overflow conditions (table 383).

Table 383 - Cropland Areas with a Wetness Problem
Subregion 9, 1966

Capability Class	Area 1000 Acres
II	159
III	133
IV	128
Total	420

Source: USDA Soil Conservation Service, C-NPRBS Data

Poorly designed tile drain system failed to function properly causing gullying and did not serve the function for which it was intended. (SCS 7-538-9)

Landowners invested over $16 million between 1937 and 1964 to drain approximately 432,000 acres, mostly cropland. Currently, about 511 miles of drain tile and 44 miles of open drains are installed annually to drain about 11,000 acres. Annual investment in drainage improvements is estimated to be $600,000. About 95 percent of this investment is by individual effort and 5 percent is accomplished by group efforts. Drainage practices applied to cropland through 1965 are shown on table 384.

Drainage requirements change with cropping patterns. A drainage system adequate for small grains or forage crops may be inadequate for strawberries, vegetables, or many other crops. About 90 percent of the drainage investment in a recent 5-year period was for tile drainage compared to about 70 percent in an

earlier period. Tile systems are preferred by farmers because they allow more efficient farming, minor maintenance costs, and no loss of productive land.

Table 384 - Drainage Practices Applied to Cropland
Subregion 9, 1966

Practice	Units	Amount
Conduits & Ditches	Miles	7,167
Drainage Structures	No.	342

Source: USDA Soil Conservation Service Data

Erosion and Sedimentation

About 1,386,000 acres of land in capability class II to IV, including 720,000 acres or 46 percent of the total cropland, have an erosion potential (table 385).

Table 385 - Cropland Areas With an Erosion Potential
Subregion 9, 1966

Capability Class	Area 1000 Acres
II	146
III	274
IV	300
Total	720

Source: USDA Soil Conservation Service, C-NPRBS Data

As estimated, 7,000 acres of cropland have received some protection while other potentially erodible areas have been adequately protected by conservation cropping systems and effective watershed management. The annual sediment yield from all cropland is about 706 acre-feet (table 379). Some two-thirds of this sediment load is produced by less than half of the cropland.

Excessive rainfall creates a major problem particularly on foothill soils and terraces in the northern part of the subregion. Large areas of these erosive soils which are deep and highly fertile have been devoted to the production of row crops and fruit and nut orchards. Winter cover crops are essential. Intensive use and machine traffic result in soil compaction and erosion.

Severe scour of a filbert orchard during overflow from the Willamette River. Soil losses reduces tree life, lowers production, and causes extensive downstream damages. (SCS F-116-6)

In the southern portion the problem is not as serious because of less erodible soils formed from native rock. There are, however, areas intensively used for strawberries and other row crops where erosion is critical.

Recent alluvial soils of the flood plains and low terraces along the Willamette River and major tributaries were developed for cropland much later than the terrace and foothill areas because of the recognized threat of floods. Recent development has been rapid and substantial acreages are brought into cultivation each year. The better-drained soils are largely devoted to the production of row crops and a high percentage is irrigated. Erosion has been serious periodically in the past even on those soils with excellent natural drainage. The extent and nature of the damage from overflows varies with location and nature of the overflow and local land use.

Sizable areas of well-drained soils which are devoted to crops such as carrots are harvested during the winter months and

are subject to serious erosion. The fine-textured, recent alluvial soils, deposited by backwater, are less susceptible to erosion.

Considerable effort has been made to reduce erosion on cropland. Erosion control practices have been applied as shown on table 386, and management methods have developed systems of farming that provide winter cover on land subject to erosion. These include winter cover crops and cropping systems that include grasses for seed, grass and legume forage crops, winter legumes for seed, and winter grain.

Table 386 - Erosion Control Practices Applied on Cropland
Subregion 9, 1966

Practice	Units	Total
Grade Stabilization Structures	No.	13
Diversions and Terraces	Miles	26
Ditch Bank Seeding	Miles	9
Crop Residue Use	1000 Acres	381.7
Grassed Waterway	1000 Acres	3.2
Conservation Cropping System	1000 Acres	555.4
Pasture and Hayland Planting	1000 Acres	77.1

Source: USDA Soil Conservation Service Data

Flooding

About 112,000 acres, two-thirds of which is cropland, are subject to annual flooding. This acreage includes 120,000 acres or 8 percent of the cropland.

Most floods occur during the months of December, January, and February. Usually sufficient rain has fallen prior to this season to provide a good vegetative cover except for some row crops and orchard lands. The extended light rainfall pattern prior to the main rainy season usually saturates the soil. Quite often floods will occur when a warming condition in the higher elevation accompanies heavy rainfall on a thick snow cover and frozen ground.

The elimination of prolonged flooding is often a prerequisite to successful drainage and/or irrigation systems. Crop damage occurs from actual flood flows, as well as excessive precipitation and flood waters that are retained on the land. Frequently, recurring floods and ponding have retarded development

of low lands to such a degree that individual landowners suffer extensive economic losses. Removal of retained waters is one of the major needs to prevent this loss and permit more intensive land use. The deposition of sediment and debris is often the most damaging result of floods to cropland, crops, roads, ditches, and natural channels. The average annual damages are $5.4 million as reported in the Willamette type 2 study and Appendix VII, Flood Control.

Flooding causes both crop and property losses. Many areas in the Willamette Valley are subject to annual flooding of this type which restricts land use. (SCS 7-75182)

A change in land use and treatment would reduce flood damage in local areas. Local flooding situations have been alleviated through stream channel improvement, streambank protection, and diking, as shown on table 387.

Table 387 - Flood Control Measures Applied on Cropland Areas, Subregion 9, 1966

Practice	Total Miles
Stream Channel Improvement	265
Streambank Protection	18
Dikes and Levees	105

Source: USDA Soil Conservation Service Data

Forest Land

Forests cover nearly 5.3 million acres or 69 percent of the total land area in the subregion. About 56 percent is in public ownership and 44 percent is private. Of this total, 94 percent is classed as commercial forest land and 6 percent is non-commerical.

The commercial forest land currently supports about 170 billion board-feet of merchantable timber, 76 percent on public land and 24 percent on private. This subregion ranks second in the region in volume of annual timber harvested. In 1964, it amounted to 3.7 billion board-feet. The commercial forest land furnishes the raw material for the subregion's forest products industries, accounting for 38 percent of its manufacturing employment.

Forested lands, representing 69 percent of the subregion, produce almost 86 percent of the surface runoff. The total urban population which includes the second largest urban center in the region, depends heavily upon these forested watersheds for its source of domestic water. Irrigation water supplies, amounting to nearly 400,000 acre-feet annually, are produced essentially on these same areas.

The forest land is generally in good condition with sediment yields amounting to about 840 acre-feet per year. This represents 45 percent of the total sediment coming from all lands in the subregion (table 388).

Table 388 - Present Sediment Yield, Forest Land, Subregion 9

Sediment Yield Category	Annual Sediment Yield				
	Acres (1,000)	Percent	Acre-Feet Per Square Mile	Total Acre-feet	Percent
Very Low	-	-	0.02 - 0.1	-	-
Low	5,171.0	98	0.1 - 0.2	808	96
Medium	101.0	2	0.2 - 0.5	32	4
High	-	-	0.5 - 1.5	-	-
Very High	-	-	1.5 - 4.0	-	-
Total	5,272.0	100		840	100

Source: Derived from figures 55 and 56.

More than 98 percent of the forest land is in the low yield category, with sediment a product of geologic erosion, logging activity and road construction. The remainder has higher yields

caused by logging and road construction activities which did not properly provide for watershed protection or rehabilitation. It is on these areas that most watershed rehabilitation work is currently conducted. Most protection practices are applied on current operating areas to prevent a reduction in present water quality.

Watershed Protection

The general timber harvest practice in the subregion is to clearcut by blocks or patches. Trees are skidded by various cable yarding systems, depending upon size and shape of clearcut, slope and terrain. Some salvage and thinning sales are logged by tractors on the more gentle terrain. In all situations extensive road systems are required.

Some timber volume is located in areas where soil and topographic conditions prohibit harvesting with today's equipment. Logging these areas depends heavily on special skyline systems, each with a different method of supporting the cable. It may be by use of intermediate trees, towers, and even balloons. In all skyline systems, however, the objective is to keep the logs from dragging across the ground as they are brought into the landing. This reduces damage to the soil cover, protects the remaining understory trees for future crops, and keeps unwanted debris out of stream channels. These systems also reduce the need for extensive access road systems by reaching out greater distances with supported cables.

On most lands, clearcut areas are planned to give adequate watershed protection by dictating size, location, shape, period of logging and access road location. Tractor trails and firelines around the harvest areas are cross-drained and some of the more critical areas are seeded to grass to provide immediate soil cover. Logging debris is removed from live streams and steep draws to prevent debris dams and washouts from occurring. In some areas, strips of timber are left adjacent to major tributaries to shade the water, cool stream temperatures, and keep debris from the channel area.

Most mainline roads are gravel surfaced all-weather roads with permanent culverts. In many cases, particularly at the crossing points on streams with anadromous fish, the excavated waste material is end-hauled and deposited away from the waterways. Exposed cut and fill slopes in erodible materials are seeded to grass so sediment would not be deposited in the streams.

Reforestation measures include both planting and aerial or hand seeding. Advance reproduction is protected from burning and

logging activity by on-the-ground administrative restrictions. The harvest activities and protection requirements are summarized on table 389.

Table 389 - Average Annual Timber Harvest Activity, Subregion 9

	Unit	Public	Private	Total
Harvest Area	Acres	26,500	39,000	65,500
Area Reforested 1/	Acres	21,200	23,400	44,600
Slash Disposal Area	Acres	13,500	7,800	21,300
Disturbed Area Treated 2/	Acres	1,300	-	1,300
Harvest Road Required	Miles	185	275	460
Harvest Road Treated 3/	Miles	140	30	170

1/ Includes planting, seeding and site preparation. Balance adequately stocked or requires no regeneration work.
2/ Includes seeding, mulching, debris removal and cross-draining skid roads and logging areas.
3/ Cut and fill stabilization only.

Watershed Rehabilitation

Forest land in the medium sediment yield category (table 388) produces 4 percent of the total sediment from the forest areas. Most of this results from water movement down abandoned roads, across old logged-off areas and along streambanks disturbed by logging practices. In places where past watershed protection measures were limited or lacking, the greatest efforts have been made to maintain or improve the present watershed condition.

Rehabilitation work on public forest land includes treatment on over 600 acres annually. Approximately 100 miles of abandoned roads and trails and 120 miles of stream are also treated (table 390).

Much of the reservoir protection work in the region has been accomplished in this subregion. National forest lands adjacent to the Corps of Engineers projects at the Hills Creek, Detroit, Cougar, Lookout Point and Blue River reservoirs have received treatment. In the past 2 years 463 acres of stump removal and 72 acres of shoreline stabilization have been accomplished in these areas. In addition, nearly 12,000 surface acres of these reservoirs have been cleared of floating debris several times to improve their recreational value.

Table 390 - Average Annual Accomplishment, Watershed Rehabilitation Practices on Public Forest Land, Subregion 9

Practice	Unit	National Forest 1/	Public Domain	Indian Lands 2/	State Lands
Sheet Erosion Control	Ac.	600	5	-	-
Gully Stabilization	Mi.	2	-	-	-
Stream Clearance & Stabilization	Mi.	110	10	-	2
Existing Road & Trail Rehab. 3/	Mi.	70	30	-	-
Reservoir Protection	Ac.	12,220	-	-	-

1/ Average of period 1964-6.
2/ Minor ownership.
3/ Includes abandoned roads.
Source: Data furnished by agency as listed.

Rehabilitation work, principally reforestation, has been done in connection with the State Forestry Department's Farm Forestry Program and the Department of Agriculture's Agricultural Conservation Program and Soil Conservation Service. This program has watershed rehabilitation benefit although the work is normally undertaken for other purposes.

Water Yield Improvement

Because water supplies are currently considered adequate, no water yield improvement work has been initiated in the subregion. Studies are being conducted on several experimental watersheds to determine the effect of timber harvest programs on peak flows, rather than on total yield.

Some modification of streamflow occurs through the normal timber harvest program and some also occurs through timber stand improvement practices such as thinning and release. These benefits are usually minor, however, and are incidental to the primary objective of timber production.

Rangeland

The 59,000 acres of rangeland in Subregion 9 consist of small areas intermingled with cropland and forest land, mostly on the rolling foothills of the Willamette Valley. About 60 percent of this acreage is privately owned. In addition to wildlife use, it provides supplemental livestock feed and rounds out the

farm operations for balanced agricultural enterprises. Some rangeland is not used agriculturally, and is being held for future urban and recreation use. About 50 percent of the rangeland is in poor condition (table 391), and the estimated average grazing capacity is little more than 4 acres per animal unit month. Most rangeland has an average annual sediment yield of about 0.15 acre-feet per square mile and produces about 14 acre-feet each year (table 392).

Table 391 - Rangeland Condition and Capacity, Subregion 9, 1966

Range Type and Condition	Ownership					
	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)
Grassland						
Good	2.3	1.5	5.0	3.4	7.3	4.9
Fair	4.8	1.1	6.5	1.5	11.3	2.6
Poor	12.3	1.4	10.4	1.1	22.7	2.5
Seeded Range 1/	.1	.1	.7	.7	.8	.8
Total	19.5	4.1	22.6	6.7	42.1	10.8
Sagebrush						
Good	--	--	--	--	--	--
Fair	--	--	--	--	--	--
Poor	--	--	--	--	--	--
Total	--	--	--	--	--	--
Other Brush						
Good	1.2	.4	3.4	1.2	4.6	1.6
Fair	1.4	.2	3.8	.5	5.2	.7
Poor	1.9	.1	5.0	.3	6.9	.4
Total	4.5	.7	12.2	2.0	16.7	2.7
Total						
Good 2/	3.6	2.0	9.1	5.3	12.7	7.3
Fair	6.2	1.3	10.3	2.0	16.5	3.3
Poor	14.2	1.5	15.4	1.4	29.6	2.9
Grand Total	24.0	4.8	34.8	8.7	58.8	13.5
Percent Distribution	40.8	35.6	59.2	64.4	100.0	100.0
Average AC/AUM	5.0		4.0		4.4	

1/ Seeded range acreage was combined with good condition grassland in Appendix IV.
2/ Includes seeded range.
Source: Rangeland narrative, C-NP Appendix IV, Subregion 9. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

Measures and Practices for Watershed Protection

Measures which provided some rangeland watershed improvement or benefit through 1965 are listed on table 393. Cover improvement and soil stabilization practices included grass seeding along with brush and weed control. About 20 percent of these efforts was for watershed purposes and 80 percent was for forage production. An estimated 50 water facilities for livestock and game have been developed, and 70 miles of livestock control fence have been constructed, reconstructed, or repaired. While these developments were mostly for other management purposes, they provided a 15 percent benefit for erosion and water quality control. About 60 check dams have been constructed on rangeland to control erosion and sedimentation.

Table 392 - Sediment Yield from Rangeland, Subregion 9, 1966

Sediment Yield Categories 1/	Grassland	Shrubs	Total	Percent
		Rangeland Acreage (1,000 Acres)		
Very Low	-	-	-	-
Low	42.1	16.7	58.8	100
Medium	-	-	-	-
High	-	-	-	-
Very High	-	-	-	-
Total	42.1	16.7	58.8	100
		Annual Sediment Yield (Acre-Feet)		
Very Low	-	-	-	-
Low	10	4	14	100
Medium	-	-	-	-
High	-	-	-	-
Very High	-	-	-	-
Total	10	4	14	100

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.
Source: Derived from figures 55 and 56.

Table 393 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Up to 1966, Subregion 9

Measures & Practices	Units	Land Ownership			Watershed Purposes 2/			
		Public 1/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	70	730	800	-	x	x	-
Brush Control	Acres	500	20,000	20,500	-	x	x	-
Weed Control	Acres	300	500	800	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	30	40	70	-	-	x	-
Livestock & Game Water Facilities	Number	20	30	50	-	-	x	-
Water Control Structures								
Check Dams (gully plugs)	Number	-	60	60	-	x	x	x
	Cu. Yds.	-	11,400	11,400	-	x	x	x

1/ Includes Federal, State, County and Municipal Ownership.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
Source: Data collected from land management agencies specifically for the C-NP Study.

Other Land

Other land covers 816,000 acres or 11 percent of the land area (table 394). Although only a comparatively small part of the subregion, this land is the most intensively used and is highly significant in terms of watershed problems and needs.

Table 394 - Other Land Areas, Subregion 9

Categories	Area (Acres)	Percent
Small Water	72,400	9
Roads and Railroads	60,000	7
Farmsteads, Urban, Industrial & Miscellaneous	555,100	68
Barren Land	128,500	16
Total	816,000	100

Source: Appendix IV, Land and Mineral Resources

Poorly drained soils impose limitations on development for residential and industrial purposes including construction of buildings, roads and streets, and the safe disposal of wastes. The reasonably safe disposal of effluents by soil absorption is impractical unless adequate areas are available. Water obtained from wells may be contaminated beyond suitability for human consumption. Without community outlets and supplementary deep drains, soils are often saturated during much of the winter season and, periodically, may have water ponded on the surface. Drainage improvements have alleviated some of these problems.

Early roads and highways were routed around areas of poorly drained soils because of construction and maintenance difficulties. Modern construction methods make it possible to cross these areas by employing special provisions of local drainage and suitable subgrades.

Under natural conditions, areas of poorly drained soils do not contribute significantly to the breeding of mosquitoes and similar insects because the water is usually on the surface only from mid-November or the first of December to mid-May. Except in areas immediately adjacent to streams, only limited habitat for these insects is available during the breeding season. As the density of population has increased, the situation has also changed. Waste water from many sources reaches poorly drained areas and collects in shallow ponds to provide breeding grounds

for insects. The problem is particularly acute in suburban developments adjacent to the larger towns and cities.

Urban flooding causes considerable monetary damages to dwellings and contents. (SCS 0-1716-2)

Wind and water erosion are not a problem in urban areas except during the construction period. Generally, the climate makes vegetal control of these areas relatively easy.

Many of the urban and suburban developments provide a variety of recreational activities such as boating, swimming, fishing, and water skiing in the Willamette and Columbia Rivers. However, pollution has tended to limit the attractiveness of the main stem of the Willamette. Some recreationists have shifted their attention to other areas.

FUTURE NEEDS

Population projections and demands for land and resource use will create additional watershed management problems in maintaining favorable watershed conditions and in improving or rehabilitating areas affected by land use changes. Population is expected to increase from 1.2 million in 1960 to 3.2 million by 2020, or

178 percent (table 395). Farm population is projected to decline from 69,000 in 1960 to 25,600 by 2020, or less than one percent of the total population.

Table 395 - Present and Projected Population
Subregion 9

	1960	1980	2000	2020
	---------------1000 persons---------------			
Total Population	1,168.9	1,727.3	2,397.6	3,237.1
Farm Population	69.0	43.4	32.8	25.6

Source: C-NP Economic Research Service

A significant increase in urban an suburban land use is anticipated in the next 50 years. Other land, which is predominantly urban, is expected to increase about 42 percent from 816,000 acres in 1966 to 1.2 million acres in 2020, an increase of 341,000 acres (table 396). Most of the increases of other lands will come from productive cropland and forest land located near existing towns and transportation systems.

Table 396 - Projected Changes in Cover and Land Use
Subregion 9

	1966	1980	2000	2020
	---------------1000 Acres---------------			
Cropland	1,456	1,384	1,420	1,250
Forest Land	5,272	5,221	5,056	5,089
Rangeland	59	55	50	48
Other Land	816	911	1,031	1,156
Total	7,603	7,571	7,557	7,543

Source: Columbia-North Pacific Projections, based on Willamette type 2 data adjusted to C-NP definitions.

Cropland

Projections indicate a greater requirement for food and fiber production, while, at the same time, urban areas are being extended into prime cropland areas. Cropland must be used more intensively and irrigation is forecasted to increase rapidly. The probable trend from dry to irrigated cropland from 1966 to 2020 (table 397) indicates an increase of more than 700,000 acres of irrigated land.

Table 397 - Projected Trends in Dry and Irrigated Cropland, Subregion 9

Cropland	1966	1980	2000	2020
	-----------------	1000 Acres	-----------------	
Dry Farmed	1,212	967	596	280
Irrigated 1/	244 2/	417	824	970
Total	1,456	1,384	1,420	1,250

1/ Approximately 97 percent of the total area projections shown in Appendix IX, Irrigation
2/ 1965 data that includes farmsteads
Source: Willamette type 2 study adjusted to C-NP definitions

Water Conservation

The need for agricultural production will require an additional 726,000 acres of irrigated cropland by 2020, a 300 percent increase. Most future irrigation will be developed by sprinkler methods. Changes in irrigation methods to meet the demand for better water management and improved efficiencies are shown in table 398.

Table 398 - Projected Cumulative Trend in Method of Irrigation on Cropland, Subregion 9

Item	1966	1980	2000	2020
	---------------	1000 Acres	---------------	
Sprinkler Systems	240	410	811	954
Flood Systems	4	7	13	16
Total	244	417	824	970

Source: Economic Research Service, C-NPRBS Projections and Willamette type 2 study adjusted to C-NP definitions.

Development of irrigation is a key factor in determining the needs for land measures due to, primarily, the relationship of drainage and proper irrigation water management. The future irrigated lands will include considerable area on steeper slopes where erosion is a hazard. Careful attention should be given to such practices as contour farming and close growing crops in order to avoid excessive erosion. Over 26,000 acres of the presently irrigated cropland are short of water during the growing season.

Drainage

Lack of drainage outlets is the major drainage problem. Community drainage outlets for 100,000 acres have been accomplished so far, and an estimated 150,000 acres will need outlet channels by 2020. The rate which the cropland areas will be drained is estimated in table 399.

Approximately 420,000 acres of cropland have a wetness problem. An increase of over 300 percent in irrigated cropland along with shifts in land use is expected to add 70,000 acres to the problem area by 2020. Drainage practices must be applied on an estimated 430,000 acres during this period.

Table 399 - Cumulative Cropland Areas Needing Drainage, Subregion 9

Item	1966	1980	2000	2020
	------------1000 Acres------------			
Problem Area	420	439	464	490
Projected Accomplishments	135	219	324	430
Remaining	285	220	140	60

Source: Soil Conservation Service, C-NPRBS Projections.

Erosion and Sedimentation

Sheet, gully, and rill erosion are estimated to be comparatively insignificant producers of sediment. About 7,000 acres of cropland have a serious erosion problem; however, 720,000 acres have an erosion potential. Some of these areas will develop an erosion pattern unless good erosion control is continued.

With anticipated shifts in land use and more intensive use of cropland, it is expected that the potentially erodible cropland will increase to 800,000 acres by 2020. However, continued and improved erosion control practices should contribute to an effective reduction in cropland erosion problems by 2020 as shown in table 400.

Sediment and its deposition effects are not a large problem; however, there are serious problems of a localized nature. Farm ponds and reservoirs having large cultivated areas within the watershed are subject to above average sedimentation rates. Accordingly, these small structures are subject to a high rate of storage loss through sedimentation.

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COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
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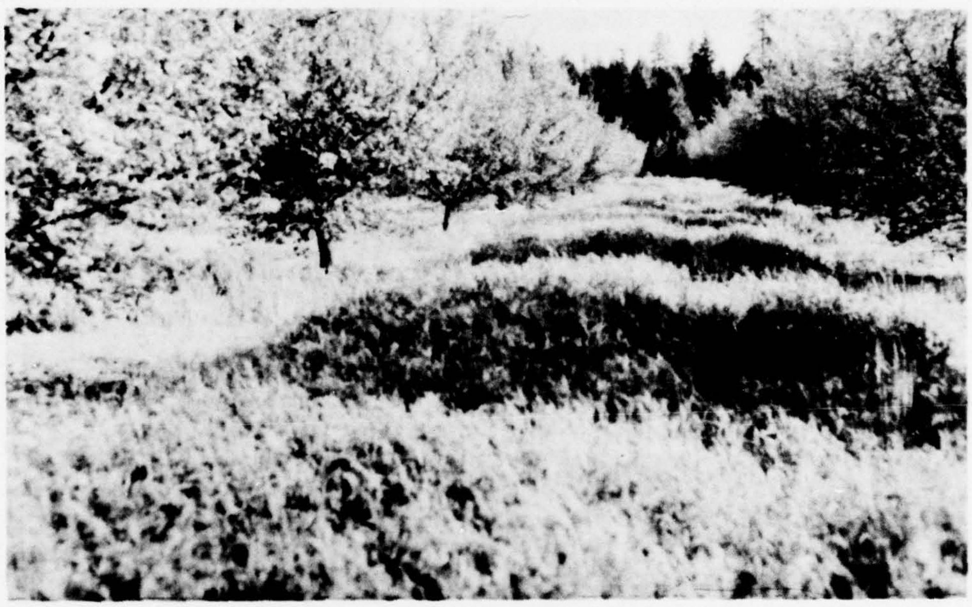
Table 400 - Cumulative Cropland Areas Needing Erosion Control, Subregion 9

Item	1966	1980	2000	2020
	------------1000 Acres------------			
Erosion Potential	720	740	770	800
Projected Accomplishments	713	735	767	799
Remaining	7	5	3	1

Source: Soil Conservation Service, C-NPRBS Projections.



Vegetative cover in orchards prevents erosion and maintains fertility. (SCS 7-550-9)

Flooding

Over 120,000 acres of cropland are subject to flooding and only a slight increase is expected because of shifts in land use. Additional reservoir storage will be required to provide necessary flood prevention.

More and better streambank protection to preserve channel alignments and to reduce bank erosion with Federal assistance is needed. As more revetments are completed, an increasing amount of maintenance work will be required.

As the authorized major flood control reservoirs are completed, there will be opportunities for levees to protect certain lower lands from flooding. Much of the necessary work has been authorized and is being carried out. In addition to the project work, there will be other minor levees needed to alleviate localized problems on farmlands. Any additional levees that may be needed should be coordinated with other previously constructed or planned projects.

Forest Land

The forest industries of the subregion will require an estimated 873 million cubic feet of raw material per year by the year 2020. This raw material will be produced principally on the 4.8 million acres of commercial forest land which are projected to remain in timber production by the end of this time period. This demand amounts to 183 cubic feet per acre and compares favorably with the present consumptive rate of 187 cubic feet per acre. Unfortunately, this still exceeds present timber growth rates (42 cubic feet per acre) by over 300 percent. The higher consumptive rate is possible only because the forest industries of the subregion presently import a large part of their raw material.

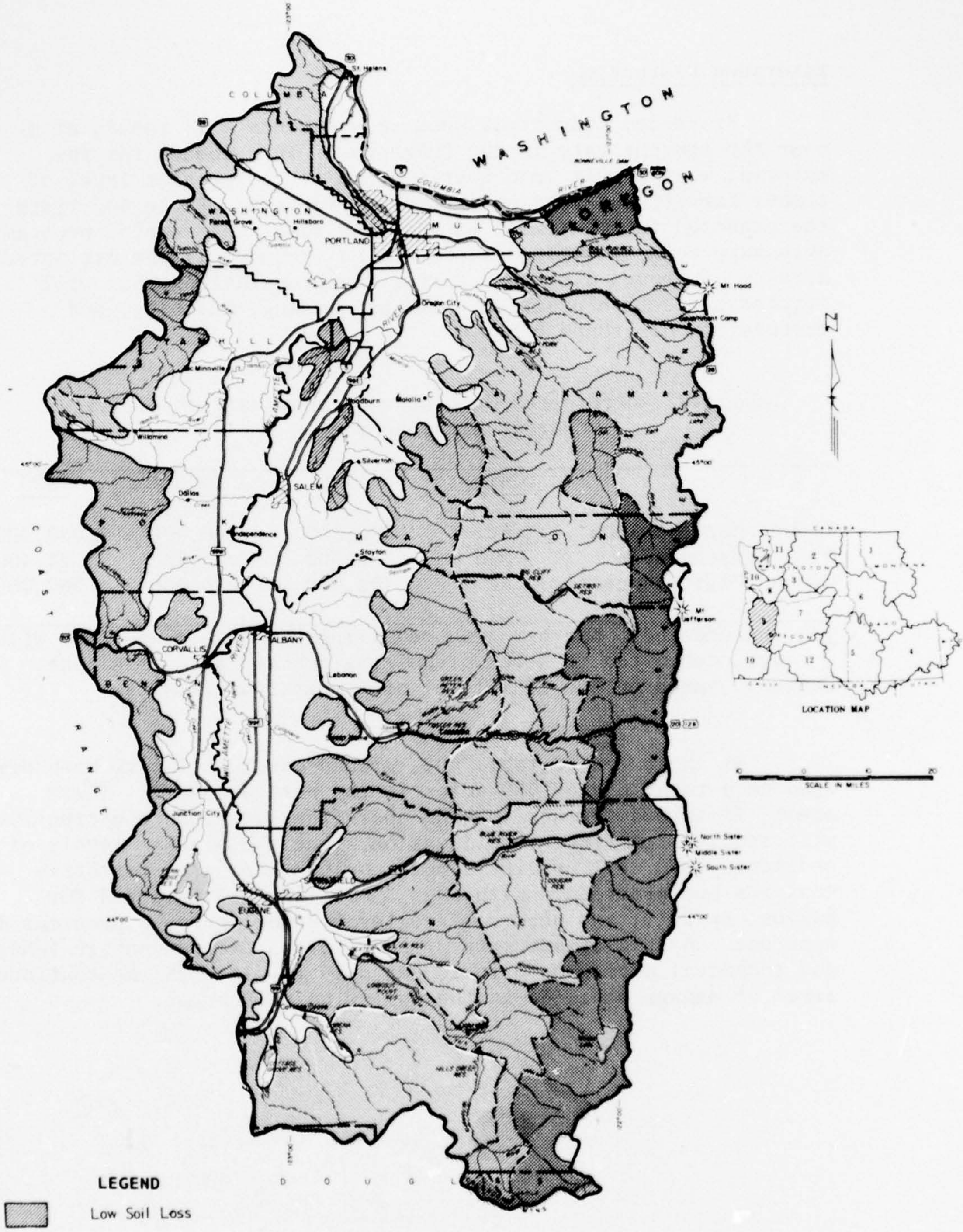
These needs cannot continue to be met in this manner, however, as neighboring subregions will also experience increased future demands. Demands may be met through such practices as improved utilization of present raw material supplies, stepped-up regeneration, fertilization, thinning, and the seeding and planting of genetically superior tree species.

Potential erosion hazard and sediment yield have been determined for the forest lands of the subregion. They are shown on figure 57 and summarized on table 401. This data represents potential yields prior to treatment or protective measures. These yields could amount to a four-fold increase over present levels.

Table 401 - Potential Sediment Yield without Protective Measures
Forest Land, Subregion 9

Soil Loss Category	Acres (1,000)	Percent	Acre-Feet Per Square Mile Per Year	Total Acre-Feet Per Year
Low	1,961.5	37	Less than 0.2	307
Medium	2,478.0	47	0.2 - 1.5	774
High	832.5	16	More than 1.5	1,952
Total	5,272.0	100		3,033

Source: Soil Survey Data & Interpretation, USDA Forest Service.



LEGEND

- Low Soil Loss
- Medium Soil Loss
- High Soil Loss

COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

POTENTIAL EROSION HAZARD FOREST LAND

WILLAMETTE, SUBREGION 9

1968

FIGURE 57

Watershed Protection

Projected industrial wood requirements will remain at or near the present rate in the subregion. This demand for raw material will result in a continuation of the present level of timber harvest and road construction programs. Table 402 lists the expected future timber harvest and road construction program necessary to meet these demands. Also included is the estimated acreage of ground disturbed during these operations that will require protection practices such as seeding, mulching, and restoration of ground cover.

Table 402 - Projected Cumulative Timber Harvest Activity
Forest Land, Subregion 9

	Unit	1980	2000	2020
Timber Harvest Area	Ac.	899,000	2,130,000	3,060,000
Road Construction	Mi.	6,300	14,900	21,400
Ground Disturbance 1/	Ac.	108,000	256,000	367,000

1/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.
Source: Based on the 1965 level of timber requirements.

As indicated in table 402, ground cover will have been damaged on a total of 367,000 acres in the next 50 years. These areas, disturbed through logging operations and road construction, will require immediate stabilization since the highest levels of sediment yield will originate here, unless adequate protective measures are provided. With over 3 million acres planned for harvest by 2020, the need for accelerated and improved programs is apparent. A lack of adequate protective measures on public lands and technical advice on private can only result with the continued level of damage depicted in the following photograph.

Tractor logging damage. Crawler tractors, using the same skid roads over and over again, have severely compacted and removed much of the soil in this area. The forester's arm indicates the original level of the forest floor. (Bureau of Land Management)

Watershed Rehabilitation

Watershed rehabilitation work is essential to water quality in all parts of the subregion. Critical areas in the medium yield category contribute the most sediment. Over 100,000 acres in this category alone need restoration work, especially abandoned roads and old logging areas.

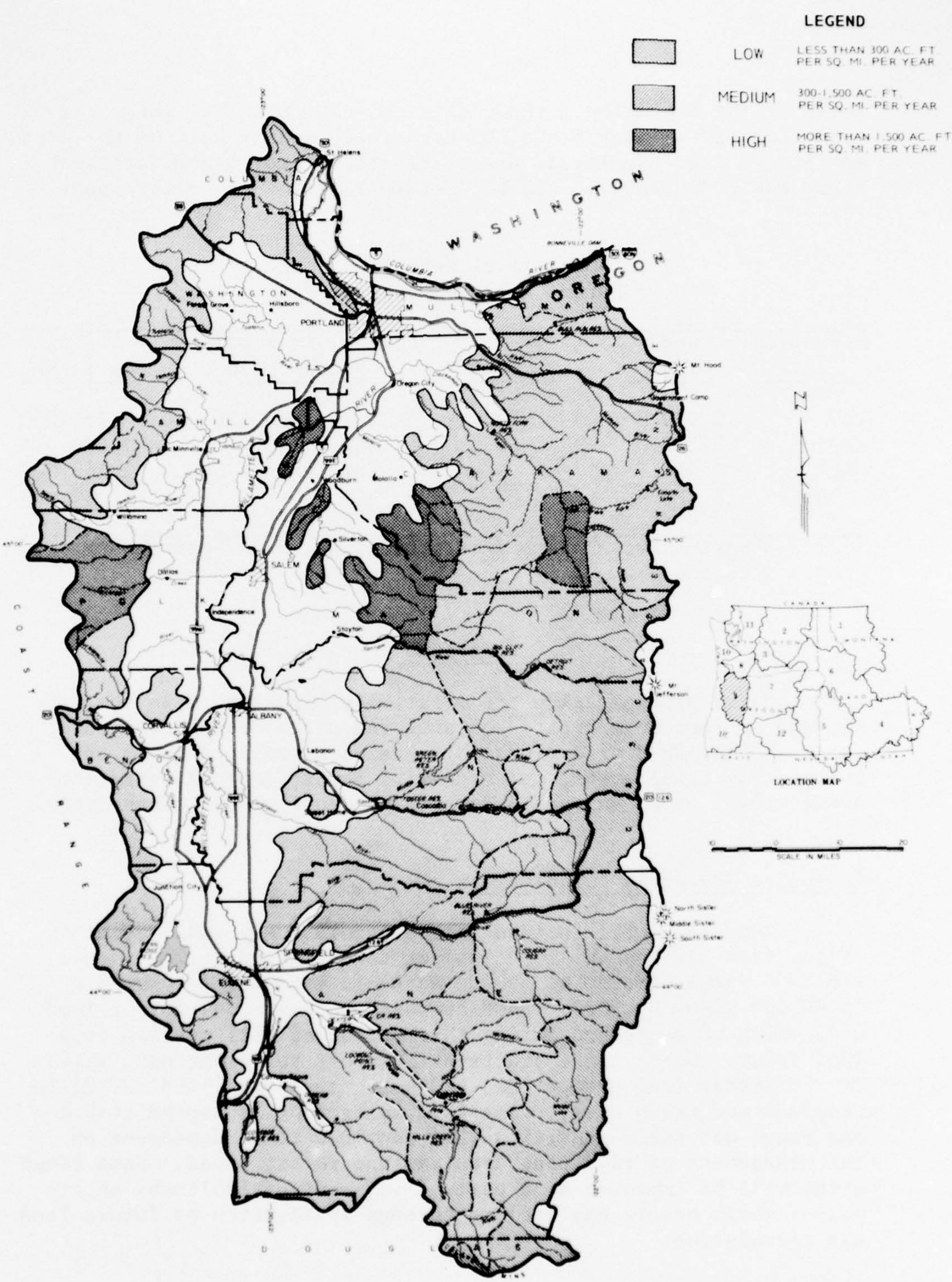
Water-based recreational demands will continue to require full utilization of the subregion's existing and proposed reservoirs. Stump and debris removal are needed to make full use possible. Pictured is the floating debris problem on Cougar Reservoir on the upper McKenzie River. Reservoir sweeping would enhance its recreational value.

Floating debris on Cougar Reservoir. This material, brought into the lake by winter high water, is a serious hazard to all water sports. Its removal improves this recreation resource. (Forest Service)

Water Yield Improvement

The forest lands will continue to be the dominant source of domestic, industrial, and agricultural water supplies. Although the total water yield is adequate for present and future needs, seasonal highs and lows in streamflow create problems in supply. The greatest demand for water coincides with the lowest streamflow. Timber harvest cutting or cover manipulation, water spreading, and snowpack management can be introduced to modify these peak flows.

The Water Retention Capacity Map (figure 58) and accompanying table indicate the potential water storage capacity of forest



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER RETENTION CAPACITY FOREST LAND

WILLAMETTE, SUBREGION 9

1968

FIGURE 58

soils of the subregion. These soils have a potential water retention capacity of over 8,000,000 acre-feet, nearly half of the present runoff from the forest area. Practices implemented on these areas would provide the highest return in terms of dollar input.

Table 403 - Water Retention Capacity
Forest Soils, Subregion 9

Retention Class	Acres (1,000)	Percent	Acre-Feet Per Square Mile	Total Acre-Feet
Low	1,528.9	29	Less than 300	715,000
Medium	3,269.0	62	300 - 1,500	4,600,000
High	474.1	9	More than 1,500	2,965,000
Total	5,272.0	100		8,280,000

Source: Soil Survey Data & Interpretations, USDA Forest Service, Region 6.

Rangeland

Heavy precipitation and relatively high runoff in the winter and spring cause erosion of some range areas where the cover has been disturbed or overgrazed. Drainage problems exist on certain low lying areas, and excessive runoff through rangeland areas causes flood damage to downstream cropland and urban areas.

Projected Use of Range Resources

Rangeland will continue to be a relatively small segment of the land area and will be subject to continued shifts in use. The 1966 range acreage of 59,000 acres is expected to decrease to 48,000 acres by 2020. Some present noncommercial forest land will shift to rangeland during this period as will certain cropland areas. Other range tracts will revert to forest use, mainly for Christmas tree production, and some areas will be diverted to cropland and urban uses. Long-term management is unpredictable and range watershed condition will continue to be dependent on the management of adjoining cropland and forest lands. Some range areas will be improved as a part of adjacent agricultural enterprises while others may decline through inattention or future land use speculation.

Watershed Needs

An estimated 11,100 acres of rangeland had received land treatment by 1966 for erosion and sedimentation control with accompanying flood control and drainage benefits. These practices have also helped improve water retention quality of the soils. An additional 2,100 acres will require treatment by 1980, 4,300 acres by 2000, and 6,500 acres by 2020.

On some 15,000 acres of rangeland, the watershed has been protected by improved management practices. These include development of water facilities for stock and game and construction of control fence to allow better livestock distribution compatible with the grazing capacity of the land, to avoid use of highly erodible areas, and to maintain protective vegetative cover. Similar practices should be extended to an additional 10,000 acres by 1980, 15,000 acres by 2000, and 18,000 acres by 2020.

Other Land

The population in the Willamette Valley is expected to increase by almost 280 percent, or from 1,168,900 to 3,237,100 by the year 2020 (table 395). This increase in population will require a shift in land use to meet the need for urban growth, industrial developments, and roads. Other land is expected to increase by over 140 percent, or from 816,000 acres to 1,156,000 acres. The shift to other land will be primarily from cropland and forest land (table 396).

Some urban areas are having difficulties now with municipal water, drainage, and flooding. New sources of water must be found to meet present problems and those that will be created from expanding populations. In addition, enlarged urban areas could experience new problems from drainage and flooding.

Of utmost importance is the need to identify deficient water quality areas and to provide necessary measures and practices which will improve the water quality standards.

MEANS TO SATISFY NEEDS

In this section of the report land measures and watershed protection needs are translated into structural and nonstructural programs and practices designed to maintain or improve watershed conditions. Their accomplishment will resolve or minimize present watershed problem areas. The means to provide watershed protection and proper management are discussed in terms of individual items which are costed in 1969 dollars. Frequently, the most effective

means to satisfy land treatment needs is to apply practices by cooperative efforts of the land owners. In a survey made of conservation needs, it was determined that 72 of the 126 watersheds of the subregion (figure 59) need accelerated planning and conservation treatment.(4) Development requirements for these watersheds are shown in table 404.

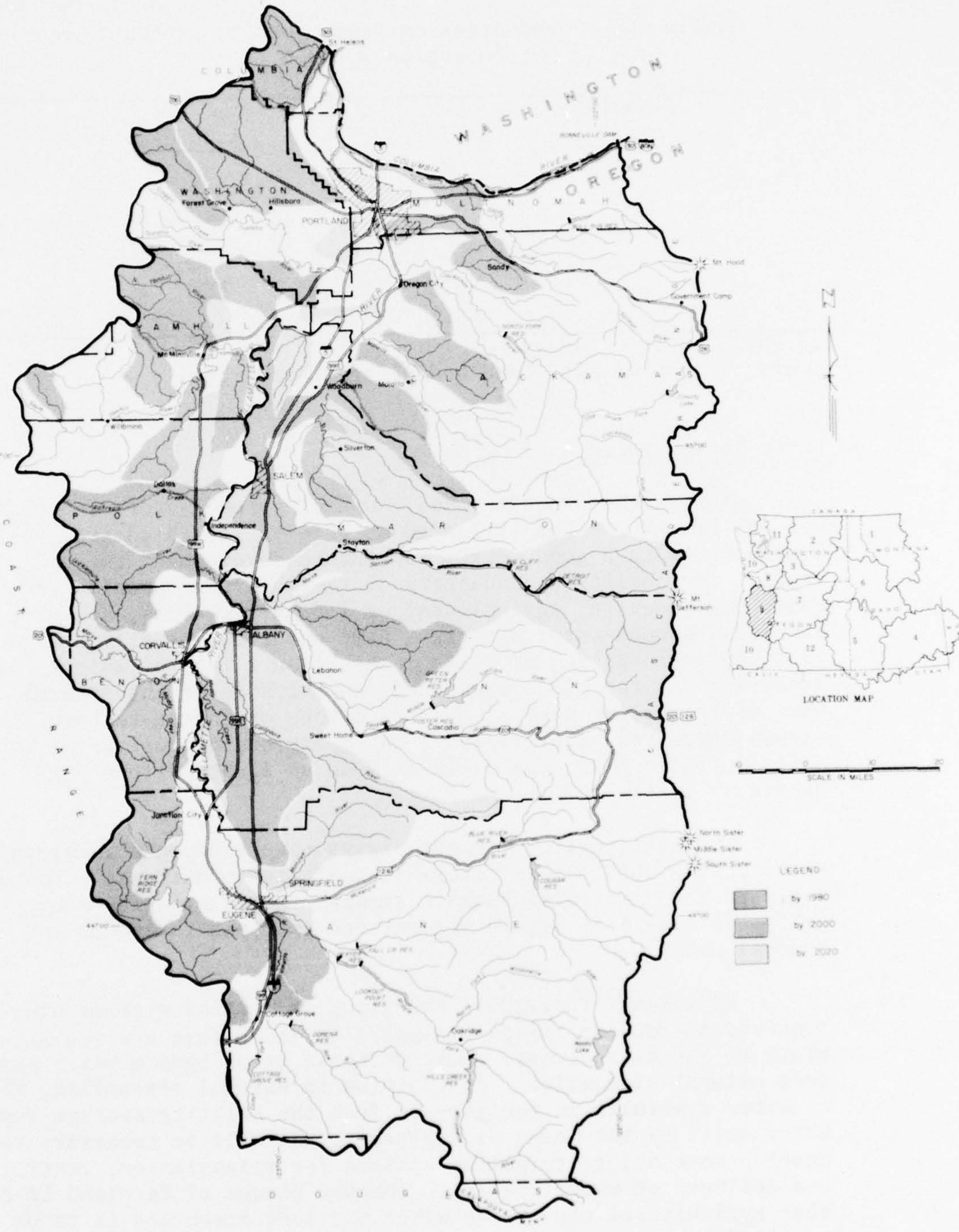
Table 404 - Practices Required for Cooperative Conservation Development, Subregion 9

Target Date	Watersheds	Flood Prevention	Erosion Control	Drainage	Irrigation New	Irrigation Supplemental	Land Treatment
	No.	------	------	------1000 Acres	------	------	------
1980	26	35.7	-	202.2	278.6	6.6	251.0
No. Watersheds	(26)	20	-	11	19	16	26
2000	23	26.6	0.7	86.7	142.2	3.6	87.4
No. Watersheds	(23)	23	8	23	23	20	23
2020	23	35.5	1.9	128.6	229.2	3.8	130.5
No. Watersheds	(23)	23	10	23	23	12	23
Total	72	97.8	2.6	417.5	650.0	14.0	468.9
No. Watersheds	(72)	66	18	57	65	48	72

Source: Soil Conservation Service, C-NPRBS Projections and Willamette type 2 study.

Cropland

Between 1966 and 2020, total cropland acreage is expected to decrease from 1,456,000 acres to 1,250,000 acres. A significant amount of dryland cropland and small areas of rangeland and forest land will shift to irrigated cropland. Land use for future periods will constantly change and projections of use are based primarily on the physical potential of individual areas for agricultural uses (table 405). Such use will be directly influenced by future urban and irrigation expansion.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

WILLAMETTE, SUBREGION 9

1968

FIGURE 59

Table 405 - Land Areas Suitable for Crop Production
Subregion 9, 1966

Capability Class 1/	Area 1,000 Acres
I	171.5
II	906.2
III	851.9
IV	872.2
Total	2,801.8

1/ Defined in Glossary
Source: Appendix IV, Land and Mineral Resources.

Water Conservation

Agriculture requires heavy use of ground water. About 41 percent of the present irrigated acreage is irrigated from wells. Ground water is a good source for future development in some areas. The quality and quantity of the water are usually adequate for domestic, agricultural, or industrial needs; however, a few local ground-water shortages have occurred, usually caused from improper spacing of wells rather than a lack of water. Some areas such as the flood plain and low terraces of the central part of the valley have a subsurface zone of coarse-textured, stream-deposited material above an impervious bedrock formation. A few wells in this area yield as much as 1,000 gallons per minute.

The hill portions do not always have a dependable ground-water supply due to less favorable geologic formations. Ground water in the underlying bedrock strata, tapped by a few deep wells, is sometimes highly mineralized and unsatisfactory for general use.

Additional individual and group irrigation systems are required to provide irrigation water to lands that are reasonably close to the main rivers. Most of these areas have a water supply from natural streamflow. In addition to natural streamflow, there is water available in the streams from the existing storage reservoirs built by the Corps of Engineers. It will be necessary to develop some major irrigation systems for transmission, control, and delivery of water to larger compact blocks of farmland if the best agricultural use of the water and land resources is to be realized.

Development of the water resources to provide adequate water supplies for agriculture will be a major purpose of future

water development projects. An estimated 1.2 million acres of existing and potential cropland could be irrigated. Better utilization of ground and surface water can result in ample water to irrigate this land.

The conservation of excessive, often damaging, runoff water in reservoirs for flood protection and subsequent use for irrigation, industry, domestic purposes, recreation, pollution abatement, and fish life has considerable potential. Construction of both large and small reservoirs will be necessary to supply water for maximum additional agricultural development (about 756,000 irrigated acres by 2020). This storage capacity can be developed where and when it is needed. A definite potential exists for more farm ponds and small reservoirs. In addition, there are many medium-sized reservoir sites of 100 to 25,000 acre-feet capacity that should be considered for water development for individual and group needs. An estimate of water control facilities and other practices for irrigated cropland by 2020 is shown in table 406.

Table 406 - Cumulative Projected Practices for Irrigated Cropland, Subregion 9

Practice	Units	1966	1980	2000	2020
Water Control Facilities	No.	57	100	200	240
Water Storage	No.	1,033	1,800	3,600	4,200
Irrigation Water Conveyance	Mi.	36	60	120	140
Land Shaping	1000 Acs.	40	70	140	160
Irrigation Water Management	1000 Acs.	140	240	480	570

Source: Soil Conservation Service, C-NPRBS Projections.

Drainage

The rate of drainage improvement will be accelerated by such things as the installation of community projects. The cost-price squeeze will force changes in agriculture. Many farmers who have been raising grass seed to the exclusion of all other crops due to the limitation of the wet soils will diversify and shift cropping patterns to meet market demands.

The expansion of irrigation will necessitate installation of drainage improvements. Project type development will assume an increasingly important role in future irrigation and most

Subsurface drainage can be accomplished by properly designed and installed tile systems. (SCS 7-1049-7)

projects will include substantial acreages needing community drainage outlets. The installation of drainage outlets along with surface or subsurface drainage will make it possible to irrigate suitable land. Projected drainage practices required are shown in table 407.

Table 407 - Cumulative Practices Required to Provide Needed Drainage, Subregion 9

Practice	Unit	1966	1980	2000	2020
Drainage Conduits & Ditches	Miles	7,167	11,040	16,200	21,500
Drainage Structures	No.	342	530	770	1,030

Source: Soil Conservation Service, C-NPRBS Projections.

Erosion and Sedimentation

Conservation and watershed management are becoming more important as land use intensifies. Improved land use along with

maintenance and improvement of watershed conditions will maximize production of goods and services. Excessive and damaging amounts of erosive overflow of water on cropland will be controlled through the use of conservation practices. Table 408 shows required practices that are expected to be installed for erosion control by the year 2020.

Table 408 - Cumulative Practices to Satisfy Erosion Control Needs, Subregion 9

Practice	Units	1966	1980	2000	2020
Grade Stabilization Structures	No.	13	15	18	20
Diversions	Miles	26	30	35	40
Ditch Bank Seeding	Miles	9	10	12	14
Crop Residue Use	1000 Acs.	382	439	516	592
Grassed Waterways	1000 Acs.	3	4	5	6
Conservation Cropping Systems	1000 Acs.	555	638	749	860
Pasture and Hayland Planting	1000 Acs.	77	89	104	119

Source: Soil Conservation Service, C-NPRBS Projections.

Flooding

Use of agricultural land on flood plains will become more intensive because they are productive, easily managed, and close to irrigation water. Detrimental characteristics include the possibility of poor drainage and the susceptibility of flooding. These potential problems make this land more adaptable to agricultural production or recreational use than to urban uses.

Single purpose reservoirs for flood control on tributary streams do not appear practical; however, multipurpose reservoirs constructed primarily for irrigation, wildlife, municipal water and recreation would also have flood control effects. Therefore, possible combination retention-detention reservoirs need to be considered in all storage projects. The projected flood prevention practices to be installed in cropland areas by 2020 are shown in table 409.

Table 409 - Cumulative Cropland Flood Prevention Practices to Satisfy Needs, Subregion 9

Practice	1966	1980	2000	2020
	Miles			
Stream Channel Improvement	265	305	358	410
Streambank Protection	18	21	24	28
Dikes and Levees	105	121	142	163

Source: Soil Conservation Service, C-NPRBS Projections.

Program Cost

The cost of implementing conservation practices discussed in the previous sections are scheduled in table 410, and are based on 1969 dollars.

Table 410 - Cumulative Estimated Cost of Cropland Conservation Practices, Subregion 9

Item	Water Conservation	Drainage	Erosion Control	Flood Prevention	Total
	1000 Dollars				
1966-1980					
Private Funds	124,280	40,180	44,086	700	209,246
Public Funds	33,040	17,220	7,602	1,400	59,262
Technical 1/	4,250	4,590	2,070	210	11,120
Total	161,570	61,990	53,758	2,310	279,628
1981-2000					
Private Funds	333,330	83,300	65,330	1,600	483,560
Public Funds	88,610	35,700	11,260	3,400	138,970
Technical 1/	11,390	9,520	3,060	500	24,470
Total	433,330	128,520	79,650	5,500	647,000
2001-2020					
Private Funds	481,870	107,100	68,160	2,800	659,930
Public Funds	128,090	45,900	11,750	4,800	190,540
Technical 1/	16,470	12,240	3,200	700	32,610
Total	626,430	165,240	83,110	8,300	883,080

1/ Includes public and private costs.
Source: Soil Conservation Service, C-NPRBS Projections.

Forest Land

Although the demand for lumber, pulpwood, and other forest products will have to stabilize at some point near 100 percent of *sustained yield, other* associated uses such as recreation and water production will continue to grow as the population increases (or proportional to population). Harvest activities and the growing demands of associated uses emphasize the need for accelerated watershed protection, a reduction in sediment levels, and vegetative management to sustain streamflow. These practices must be a part of the orderly development of the structural programs of the subregion.

Watershed Protection

It is anticipated that the intensity of watershed protection conducted concurrently with logging and road construction activity, as outlined in table 389 will accelerate or at least continue at present levels on the public forest lands. By the year 2020, standards on private areas should be at least on a level of those presently utilized on public forest lands, especially on erosive sites with a high sediment yield potential. Table 411 outlines the anticipated total cost of such measures, accumulated through the year 2020. These costs are based upon the assumption that: (1) on the public forest lands, controls through timber sale and construction contracts are adequate if properly applied; and, (2) on the private forest lands, minimum controls required in year 2020 will about equal that presently in effect on the public lands.

At the rate projected in table 411, recurrent watershed protection measures will cost about $1,760,000 annually on the public forest lands and should cost $1,270,000 annually on the private. Converting the annual costs to totals, this amounts to $166,720,000. This represents the cost of maintaining the productive condition of the forest watersheds under the pressures of the projected demands.

Table 411 - Projected Costs for Watershed Protection Practices
Forest Land, Subregion 9

Practices	Unit	Total Units 1/	Total Cost 1/ $1000
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	73,000	2,190
Harvest Road Treatment 2/	Mi.	10,200	2,550
Other Watershed Requirements 3/	Ac.	2,954,000	92,190
Total Cost			96,930
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	80,000	2,000
Harvest Road Treatment	Mi.	11,200	2,240
Other Watershed Requirements	Ac.	2,304,000	65,550
Total Cost			69,790
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	153,000	4,190
Harvest Road Treatment	Mi.	21,400	4,790
Other Watershed Requirements	Ac.	5,258,000	157,740
Total Cost			166,720

1/ Total for 55-year period 1965-2020. Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, timber cultural practices, and other indirectly related items.

Watershed Rehabilitation

The forest areas most in need of rehabilitation are those in the medium yield categories as listed in table 413. Annual sediment yield from those areas could be reduced by 28 acre-feet or 71 percent of the total reduction for the subregion.

Table 412 lists the forest land acreage presently requiring treatment and the amount that should be accomplished during time periods 1980, 2000, and 2020. Table 413 presents the expected sediment reduction through the application of these measures. The overall expected sediment reduction rate is about 5 percent, or 40 acre-feet per year. This represents that portion of the sediment yield generally amplified by land use activities.

In addition to the needs for sediment reduction on the presently eroding forest lands, nonrecurrent work will be required on any future forest burns or lands directly related to future water storage projects. The sediment sources will be treated as they occur. Therefore, the 5 percent overall sediment reduction is the amount possible excluding new sources occurring from major fire or other natural disasters.

Table 412 - Projected Watershed Rehabilitation Programs
Forest Land, Subregion 9

Program	Unit	1980		2000		2020	
		Amount	Cost 1/ $1000	Amount	Cost 1/ $1000	Amount	Cost 1/ $1000
FEDERAL LAND							
Land Treatment	Ac.	9,120	1,442	6,000	960	5,000	800
Stream Rehabilitation	Mi.	462	7,372	177	2,192	174	2,245
Road Rehabilitation	Mi.	569	99	687	102	310	50
Total Cost			8,913		3,254		3,095
NON-FEDERAL LANDS							
Land Treatment	Ac.	20,100	308	20,100	308	20,100	308
Stream Rehabilitation	Mi.	123	615	43	215	41	205
Road Rehabilitation	Mi.	161	9	163	9	105	5
Total Cost			932		532		518
TOTAL LANDS							
Land Treatment	Ac.	29,220	1,750	26,100	1,268	25,100	1,108
Stream Rehabilitation	Mi.	585	7,987	220	2,407	215	2,450
Road Rehabilitation	Mi.	730	108	850	111	415	55
Total Cost			9,845		3,786		3,613

1/ In 1969 Dollars.

Table 413 - Expected Annual Sediment Reduction
Forest Land Rehabilitation, Subregion 9

Present Yields 1/	Acres (1,000)	Total Sed. Yield Ac.-Ft./Yr.	Acres Treated 2/	Sediment Reduction Ac.-Ft./Yr.
Very Low	-	-	-	-
Low	5,171.0	808.0	74,000	11.6
Medium	101.0	31.6	101,000	28.4
High	-	-	-	-
Very High	-	-	-	-
Total	5,272.0	839.6		40.0
		Total reduction, percent		5

1/ Data from table 388.
2/ Data from table 412. Miles treated converted to acres.

Water Yield Improvement

Manipulation of the forest cover and water spreading practices have the potential for modifying streamflows from tributary streams in the subregion. Water yield improvement programs that should be accomplished between now and 2020 are listed on table 414. As discussed in the Regional Summary, timber cover on private forest lands is adjusted principally to meet logging requirements. Therefore, neither water yield improvement practices nor benefits are estimated, although some benefit does occur.

Total Program Costs

In summary, the total cost of forest watershed protection and land treatment programs through the year 2020 may be expressed as follows:

	Costs ($1,000)
Watershed Protection	166,720
Watershed Rehabilitation	17,244
Water Yield Improvement	236
	184,200

Table 414 - Projected Water Yield Improvement Practices, Public Forest Land, Subregion 9

Program	Unit	1980 Amount	1980 Cost[1/] $1000	2000 Amount	2000 Cost[1/] $1000	2020 Amount	2020 Cost[1/] $1000
Cover Manipulation [2/]	Ac.	100	1	100	1	1,600	24
Snowpack Management	Mi.	2	100	-	-	-	-
Water Spreading[3/]	Ac.	2,050	25	3,600	43	3,500	42
Total Cost			126		44		66

1/ In 1969 Dollars.
2/ Includes type conversion and riparian vegetation management.
3/ Planned for altering timing of runoff or ground-water recharge, not for irrigation or other resource activity.

Rangeland

Measures and Practices for Watershed Protection

Required measures to satisfy future needs for range watershed protection and improvement are shown on tables 415, 416, and 417. Most of these practices also have other management objectives or purposes. Cover improvement and soil stabilization practices will be required on an estimated 13,000 acres of rangeland between 1966 and 2020. About 3,800 acres will need revegetation for soil stabilization and improved forage for livestock and wildlife. On some 4,000 acres, brush will be controlled, 3,900 acres will be fertilized, 340 acres will be contoured, weeds will be controlled on about 900 acres, and 90 acres should be irrigated. About 25 percent of these efforts will be for watershed objectives while the remaining 75 percent will be for other management purposes such as forage production.

Between 1966 and 2020, an estimated 430 miles of livestock control fence should be constructed, reconstructed, or repaired, and an additional 60 livestock and game water facilities developed. About 30 percent of the fencing and 10 percent of the water facilities will be for erosion and water quality control through better stock distribution to avoid erodible areas and maintain protective cover. Numerous small size parcels of rangeland, and continual shifts in grazing use require a relatively large number of water facilities and mileage of fencing.

Table 415 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Subregion 9

Measures & Practices	Units	Land Ownership Public 2/	Land Ownership Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	300	400	700	x	x	x	x
Brush Control	Acres	800	1,200	2,000	-	x	x	-
Weed Control	Acres	100	200	300	-	x	x	-
Fertilizing	Acres	400	600	1,000	-	-	x	-
Contouring, Pitting, Furrowing	Acres	70	100	170	-	x	x	x
Irrigation	Acres	10	20	30	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	50	80	130	-	-	x	-
Livestock & Game Water Facilities	Number	10	20	30	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	3	4	7	x	x	x	-
	Acre Ft.	3	4	7	x	x	x	-

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col.1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col.4-Flood & Debris Control.
2/ Includes Federal, State, County and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Table 416 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1981 to 2000, Subregion 9

Measures & Practices	Units	Land Ownership Public 2/	Land Ownership Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	500	800	1,300	x	x	x	x
Brush Control	Acres	500	800	1,300	-	x	x	-
Weed Control	Acres	100	200	300	-	x	x	-
Fertilizing	Acres	500	800	1,300	-	-	x	-
Contouring, Pitting, Furrowing	Acres	70	100	170	-	x	x	x
Irrigation	Acres	10	20	30	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	50	80	130	-	-	x	-
Livestock & Game Water Facilities	Number	10	20	30	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	3	4	7	-	x	x	-
	Acre Ft.	3	4	7	-	x	x	-

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Table 417 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2001 to 2020, Subregion 9

Measures & Practices	Units	Land Ownership Public 2/	Land Ownership Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	700	1,100	1,800	x	x	x	x
Brush Control	Acres	300	400	700	-	x	x	-
Weed Control	Acres	100	200	300	-	x	x	-
Fertilizing	Acres	600	1,000	1,600	-	-	x	-
Irrigation	Acres	10	20	30	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	70	100	170	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	3	4	7	-	x	x	-
	Acre Ft.	3	4	7	-	x	x	-

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Erosion and Sediment Yield Improvement

Practices shown on tables 415, 416, and 417 for erosion and water quality control will be beneficial in some of the small eroded areas having higher sediment yield. Yet, in the shift of land use and ownership, other areas will receive no watershed attention, causing more erosion and sediment problems. The projected sediment yield is shown on table 418 with a decline of 21 percent by 2020. This is due in part to watershed measures and practices and in part to a reduced rangeland acreage.

Table 418 - Sediment Yield Projections from Rangeland, Subregion 9

Sediment Yield Categories 1/	1966	1980	2000	2020
		Rangeland Acreage (1,000 Acres)		
Very Low	-	-	-	-
Low	58.8	55.0	50.0	48.0
Medium	-	-	-	-
High	-	-	-	-
Very High	-	-	-	-
Total	58.8	55.0	50.0	48.0
Percent Change From 1966	.0	-6.5	-15.0	-18.4
		Annual Sediment Yield (Acre-Feet)		
Very Low	-	-	-	-
Low	14	13	12	11
Medium	-	-	-	-
High	-	-	-	-
Very High	-	-	-	-
Total	14	13	12	11
Percent Change From 1966	0	-7	-14	-21

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.

Improved Range Condition and Capacity

Considering the nature of the rangeland and the small acreage involved, little improvement is anticipated. Potential future range condition trends are shown on table 419. In 1966, 22 percent of the rangeland was in good condition. With scheduled improvements, good condition range will be increased to 28 percent by 2020. Poor condition range which accounted for 50 percent of the total rangeland in 1966, will decrease to about 44 percent by 2020. Grazing capacity is projected to increase from 13,500 to 13,700 animal unit months in 2020 in spite of an 18 percent decrease in total range acreage.

Estimated Program Costs

Investment cost estimates (based on 1969 dollars) are given in table 420 for all practices shown on table 415, 416 and 417. Cover improvement and soil stabilization programs will require $58,000 between 1966 and 2020, or 21 percent of the total rangeland watershed program costs of $280,800. Watershed oriented land management costs require $215,000 or 76 percent of the total, and water control structures require $7,800 or about 3 percent of all costs.

Table 419 - Estimated Potential Rangeland Improvement, Subregion 9

Range Type and Condition	1966		1980		2000		2020	
	Acres (1,000)	AUM'S (1,000)	Acres (1,000)	AUM'S (1,000)	Acres (1,000)	AUM'S (1,000)	Acres (1,000)	AUM'S (1,000)
Grassland								
Good	7.3	4.9	6.8	4.5	6.2	4.1	6.0	4.0
Fair	11.3	2.6	10.6	2.5	9.6	2.2	9.2	2.1
Poor	22.7	2.5	20.6	2.3	17.6	2.0	15.5	1.7
Seeded Range	.8	.8	1.4	1.4	2.4	2.4	3.7	3.7
Total	42.1	10.8	39.4	10.7	35.8	10.7	34.4	11.5
Sagebrush								
Good	-	-	-	-	-	-	-	-
Fair	-	-	-	-	-	-	-	-
Poor	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-
Other Brush								
Good	4.6	1.6	4.3	1.4	3.9	1.3	3.8	1.3
Fair	5.2	.7	4.9	.7	4.4	.6	4.2	.6
Poor	6.9	.4	6.4	.4	5.9	.4	5.6	.3
Total	16.7	2.7	15.6	2.5	14.2	2.3	13.6	2.2
Total								
Good 1/	12.7	7.3	12.5	7.3	12.5	7.8	13.5	9.0
Fair	16.5	3.3	15.5	3.2	14.0	2.8	13.4	2.7
Poor	29.6	2.9	27.0	2.7	23.5	2.4	21.1	2.0
Grand Total	58.8	13.5	55.0	13.2	50.0	13.0	48.0	13.7
Average AC/AUM	4.4		4.2		3.9		3.5	
Percent change from 1966	.0	.0	-6.5	-2.4	-15.0	-4.0	-18.7	+1.8

1/ Includes seeded range.
Source: Table 391. Future estimates for this study are based on representative on-site surveys for production guides with consideration to the capability of the range for improvement with proper management and utilization.

Table 420 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Subregion 9

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
	Public Land			
Cover Improvement and Soil Stabilization	8.1	7.4	6.6	22.1
Watershed Oriented Land Management Practices	25.0	25.0	35.0	85.0
Water Control Structures	1.1	1.1	1.1	3.3
Total	34.2	33.5	42.7	110.4
	Private Land			
Cover Improvement and Soil Stabilization	12.6	12.5	10.8	35.9
Watershed Oriented Land Management Practices	40.0	40.0	50.0	130.0
Water Control Structures	1.5	1.5	1.5	4.5
Total	54.1	54.0	62.3	170.4
	Total			
Cover Improvement and Soil Stabilization	20.7	19.9	17.4	58.0
Watershed Oriented Land Management Practices	65.0	65.0	85.0	215.0
Water Control Structures	2.6	2.6	2.6	7.8
Total	88.3	87.5	105.0	280.8

Source: Based on measures and practices shown on tables 415, 416, and 417 with constant 1969 dollars.

Other Land

The increase of other land areas by about 340,000 acres will create problems in water supply, drainage, flooding, sewage disposal, etc. unless careful and coordinated planning is done in advance. In addition, there is a continuing trend toward occupation of good agricultural land by nonagricultural uses such as urban, industrial, airports, and highways. Such a shift in land use results in permanent loss of needed productive agricultural resources.

The present primary purpose of land zoning is to meet urban and suburban needs. Procedures for protecting the agricultural resources must also be developed. Land zoning should be extended to areas with drainage problems or areas which are subject to sliding or flooding. This zoning could either exclude construction from problem areas or define the procedure necessary to overcome the problem.

The structural and land treatment measures necessary to provide protection to other land has been included and costed elsewhere in this appendix and in Appendixes VII, Flooding; IX, Irrigation; and XI, Municipal and Industrial Water Supply.

LOCATION MAP

SUBREGION 10

SUBREGION 10
COASTAL

PRESENT STATUS

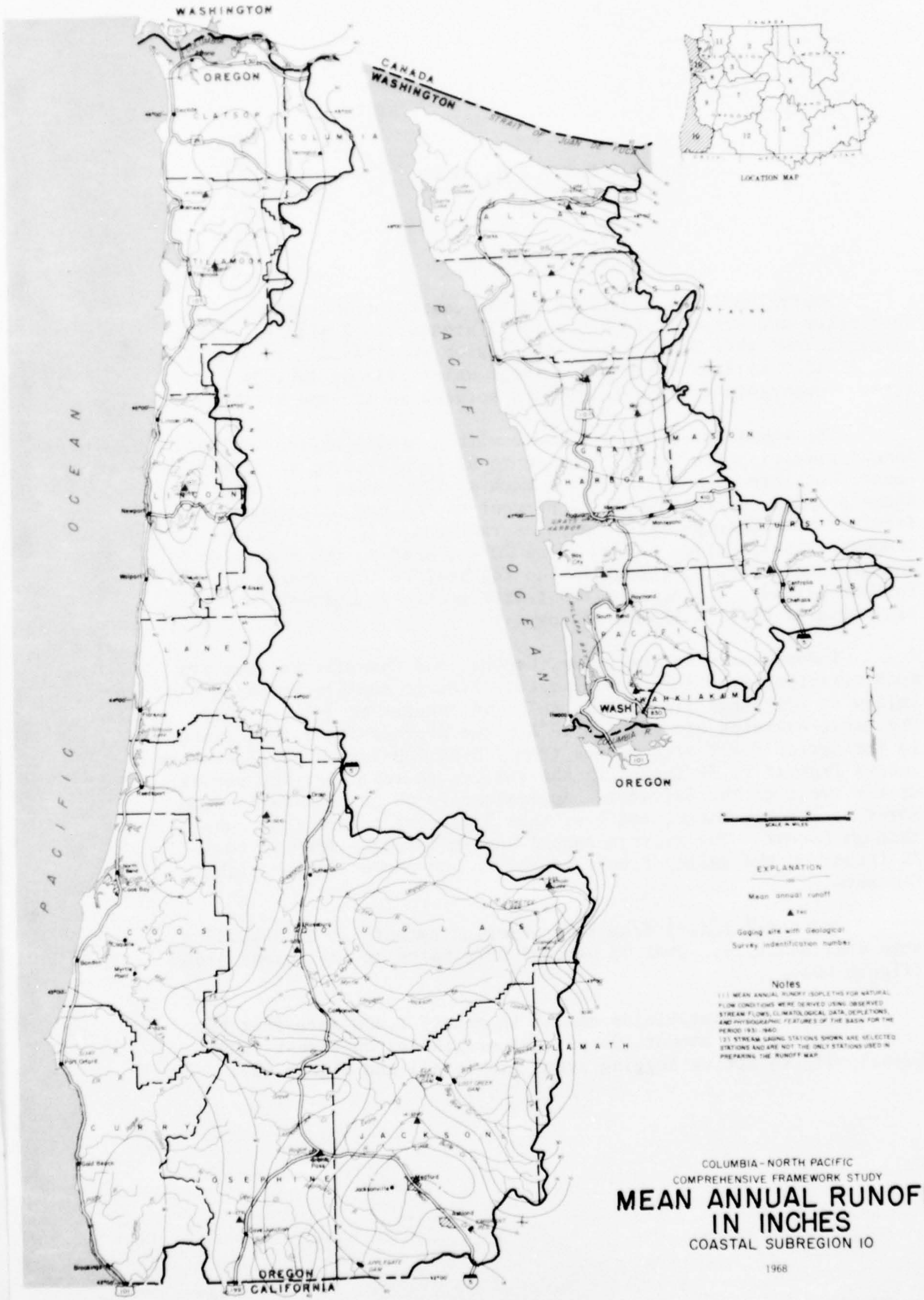
Subregion 10 is comprised of the coastal tributaries in Washington and Oregon. It has a total area of 15.2 million acres, slightly less than 9 percent of the region and includes a land area of 15.1 million acres and a large water area of 100,000 acres. Ownership is equally divided between public and private.

The coast has a humid climate with a strong marine influence. Annual precipitation ranges from 60 to 90 inches along the immediate coast, but increases inland to as much as 200 inches along the Coast Range summit. Approximately 70 percent of the precipitation occurs from November through March, both as rain and snowfall. Winter temperatures are mild, seldom below 20°F., even in the mountains. Summer temperatures are cool in the fog belt but can approach 100°F. further inland. The average frost-free season in most of the agricultural area is 180 to 300 days.

Temperatures in the Rogue, Umpqua, and Chehalis valleys are much different from the coastal area. Average monthly means on the valley floors range from 35° to 40°F. in January to 70°F. in July. The usual extremes are 105° to 15°F. The average frost-free season in the agricultural area ranges from 140 to 230 days. Precipitation ranges from 14 to 35 inches in the valleys to well over 100 inches at the crest of the Cascades. Approximately 65 percent falls from November through March, and less than 8 percent occurs from June through August. The average annual snowfall ranges from 10 to 45 inches on the valley floors to 500 to 900 inches in the high Cascades.

The total runoff from the subregion amounts to 63.4 million acre-feet annually. Over 93 percent originates on the forest areas (figure 60).

Total sediment yields amount to nearly 2,400 acre-feet per year. The largest amount (92 percent) originates on forest land, principally in active logging areas (table 421 and figure 62).



EXPLANATION

Mean annual runoff

Gaging site with Geological Survey indentification number

Notes

(1) MEAN ANNUAL RUNOFF ISOPLETHS FOR NATURAL FLOW CONDITIONS WERE DERIVED USING OBSERVED STREAM FLOWS, CLIMATOLOGICAL DATA, DEPLETIONS, AND PHYSIOGRAPHIC FEATURES OF THE BASIN FOR THE PERIOD 1931-1960.

(2) STREAM GAGING STATIONS SHOWN ARE SELECTED STATIONS AND ARE NOT THE ONLY STATIONS USED IN PREPARING THE RUNOFF MAP.

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL RUNOFF IN INCHES

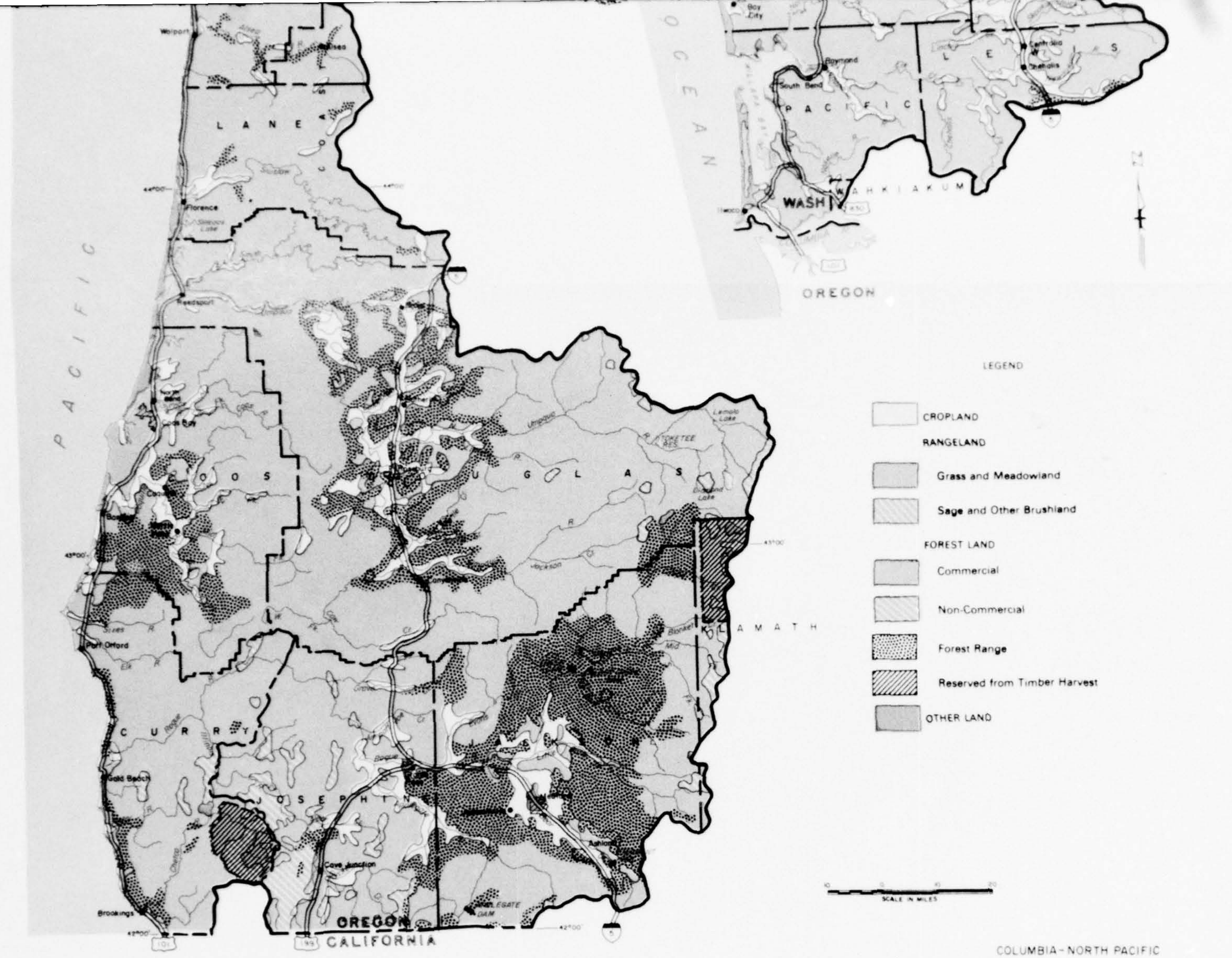
COASTAL SUBREGION 10

1968

FIGURE 60

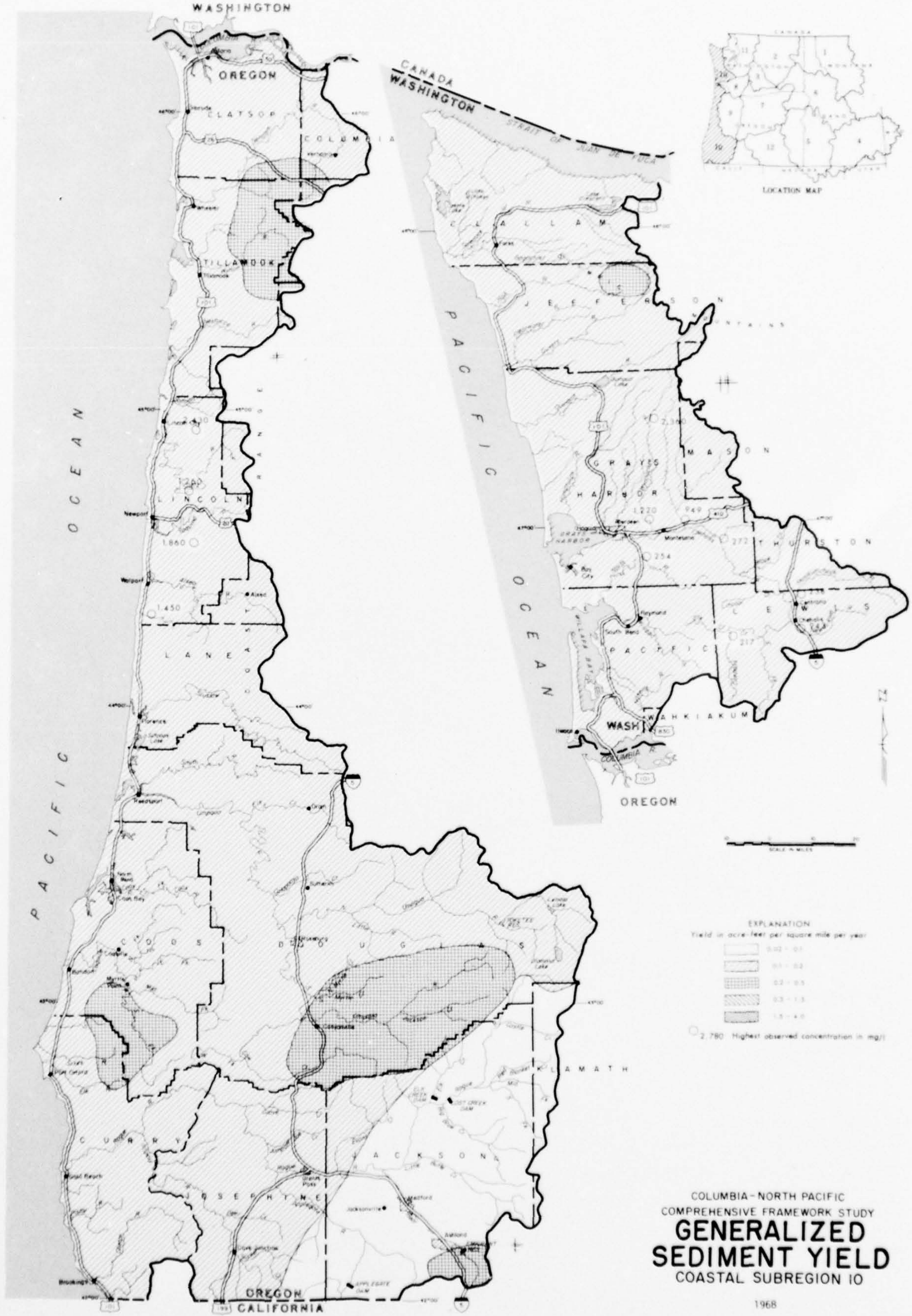
WASHINGTON
OREGON
CLATSOP
COLUMBIA
TILLAMOOK
LINCOLN
LANE
OCEAN
PACIFIC
Seaside
Newport
Waldport
Florence
Reedsport
Lincoln City
CANADA
WASHINGTON
CLALLAM
JEFFERSON
OLYMPIC MOUNTAINS
GRAYS HARBOR
MASON
THURSTON
LEWIS
PACIFIC
WAHKIAKUM
WASH
PACIFIC OCEAN
OREGON
Forks
Aberdeen
Hoquiam
Montesano
Raymond
South Bend
Bay City
Chehalis
LOCATION MAP
CANADA
LEGEND
CROPLAND

2



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY
GENERALIZED COVER AND LAND USE
COASTAL, SUBREGION 10
1968

FIGURE 61



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

COASTAL SUBREGION 10

1968

FIGURE 62

Table 421 - Generalized Sediment Yield by Cover and Land Use, Subregion 10

Cover and Land Use	1,000 Acres	Percent	Sediment Yield (Ac.-Ft./Yr.)	Percent
Cropland	584.8	4	142	6
Forest Land	13,828.6	92	2,187	92
Rangeland	168.6	1	37	2
Other Land	472.2	3	11	0
Total	15,054.2	100	2,377	100

Source: Derived from figures 61 and 62 and Appendix IV.

Cropland

With the exception of larger dairy farms, specialty and fruit farms, and some of the livestock ranges, farming is a part-time endeavor. It is estimated that no more than a fourth of the operators are solely dependent upon income from farming, and only about 45 percent are commercial operations. The others are part-time or part-retirement farms. Most part-time farmers work as loggers or in a job related to the forest industry. Small acreages are used to produce products for their own consumption or as a supplemental source of income. Only about 16 percent of the area capable of producing agricultural crops is in cropland.

Based on agriculture, Subregion 10 can be divided into two areas. The coastal areas of Oregon and Washington have marine oriented climates and problems peculiar to those areas. The Rogue, Umpqua, and Chehalis valleys are in the interior of Oregon and Washington.

In the coastal area, pasture, hay, and silage are the most extensively grown crops and provide a major feed base for dairy and livestock farms. Most cropland located on the flood plains adjacent to major streams is presently limited to the production of pasture and forage crops because of frequent flooding and inadequate drainage. On suitable bottom lands and low terraces, a few specialty crops such as cranberries and lily bulbs are grown. Also, cool climate crops, such as artichokes and broccoli, are being grown on a trial basis around Tillamook, Oregon.

Cropland in the Umpqua Basin is found on the bottomlands and terraces of streams. Of the 95,300 acres of cropland, 81,300 acres are nonirrigated and 14,000 acres are irrigated. Hay and pasture for livestock production is the most important crop. Fattening of lambs has been a major livestock enterprise, but is decreasing, while beef cattle production is increasing. A number

of other crops are grown, such as, corn, beans, cantaloupe, melons, and filberts. Only hay, pasture, and small grain are grown under dryland conditions.

Cropland in the Rogue Basin is located mostly on bottomlands and terraces along streams. Of the 158,900 acres of cropland, slightly more than 40,000 acres are dry cropped and just under 119,000 acres are irrigated. The major crop in the Rogue Basin, except Bear Creek Valley, is hay and pasture. Most of this is used locally for the production of livestock, predominately beef. A small amount of grain and corn for silage is grown throughout the basin. Truck gardening has been minor in the past but is steadily increasing. In the Bear Creek Valley, orchards, mostly pears, are the highest income producing crop. Eleven thousand acres of orchards produced about 60 percent of the agricultural income in 1967. Hay and pasture, comprising some 30,000 acres, produced about 8 percent; and beef production added another 9 percent. Dairy products accounted for 11 percent in 1967, and other crops and livestock for the remaining 12 percent of the income.

Hay and pasture is the major crop in the Chehalis River Valley of Washington. The major income producing enterprise is dairying. However, the importance of dairying is decreasing, while beef production is increasing. In addition, turkey and chicken production is becoming significant. Poultry ranges on pastures and beef cattle utilize the remaining grass. Crops such as peas, corn, and strawberries are grown for canneries. Although the acreages are still small, caneberry production is increasing.

The cropping pattern of the subregion by states is shown in table 422.

Water Conservation

As is true throughout the region, the major water conservation problems are related to both the annual precipitation and its distribution. Since most of the precipitation is received in the winter, streamflows are reduced or nonexistent during the irrigation season. A number of practices have been effective to overcome some of these problems (table 423).

Of the 175,200 acres irrigated in Subregion 10, about 40,000 acres are located in the coastal areas. Irrigation is more or less a marginal venture in these areas. The average rainfall from June through August is 10 inches, which is not enough to grow forage crops. However, about half of the years exceed 10 inches; and in about 1 year in 5 to 8 years enough precipitation is received so that irrigation is not required.

Table 423 - Water Conservation Practices Applied on Cropland, Subregion 10, 1966

Practice	Units	Oregon	Washington	Total
Water Control Facilities	No.	1,727.0	207.0	1,934.0
Irrigation Water Conveyance Facilities	Miles	398.0	9.0	407.0
Water Storage Facilities	No.	772.0	265.0	1,037.0
Irrigation Systems: Surface and Subsurface	No.	2,787.0	0.0	2,787.0
Irrigation Systems: Sprinkler	No.	1,015.0	571.0	1,586.0
Land Shaping	1,000 Acres	35.2	2.5	37.7
Irrigation Water Management	1,000 Acres	30.8	8.1	38.9

Source: Soil Conservation Service Data.

Table 422 - Types of Crops, Subregion 10, 1966

State	Hay & Pasture	Grain	Other 1/	Total
	1000 acres			
		Dry Cropland		
Oregon	250.0	7.0	4.1	261.1
Washington	144.7	1.2	2.6	148.5
Total	394.7	8.2	6.7	409.6
		Irrigated Cropland		
Oregon	136.3	13.1	12.9	162.3
Washington	8.6	--	4.3	12.9
Total	144.9	13.1	17.2	175.2
Total Cropland	539.6	21.3	23.9	584.8

1/ Includes berries, bulbs, cranberries, safflower, mint, hops, grain, grass seed, and silage corn.
Source: Appendix IV, Land and Minerals.

In the interior basins of the Rogue, Umpqua, and Chehalis rivers about 135,000 acres are irrigated. The Rogue Basin is the only area with an appreciable amount of flood irrigation. Over 108,000 acres have surface irrigation systems; the remainder is predominantly sprinkler irrigated.

In the coastal area, over 38,000 acres are irrigated from streamflow, 5,400 acres from ground water, and only 500 acres from reservoir storage. In contrast, over 63,000 acres are irrigated from reservoir storage, over 67,000 acres from streamflow, and only 600 acres from ground water in the Rogue and Umpqua valleys.

In the Chehalis Basin, streamflows furnish water for most of the irrigation at the present time. During drier years, flows are low at the time of peak use. Farmers are beginning to develop wells to supplement or replace streamflow.

The present status of water availability and irrigation use is shown in table 424.

Table 424 - Water Availability and Irrigation Methods, Subregion 10

Item	Oregon	Washington	Total	Percent
	-------1000 acres---------			
Water Source				
Streamflow	98.4	7.2	105.6	60
Groundwater	1.1	5.4	6.5	4
Reservoir Storage	62.8	0.3	63.1	36
Total	162.3	12.9	175.2	100
Area with adequate supply	136.1	12.3	148.4	85
Area with inadequate supply	26.2	0.6	26.8	15
Method of Application				
Sprinkler	53.6	12.9	66.5	38
Flooding	108.7	--	108.7	62

Source: Soil Conservation Service, C-NPRBS Data.

Drainage

There are over 190,000 acres of cropland in this subregion that have a wetness problem (table 425). Of this, over 150,000 acres are in the coastal areas of Oregon and Washington and 40,000 acres are in the Rogue and Chehalis valleys.

Table 425 - Cropland Areas with a Wetness Problem, Subregion 10, 1966

Capability Class	Oregon	Washington	Total
		(1,000 acres)	
II	29	23	52
III	24	22	46
IV	40	54	94
Total	93	99	192

Source: Soil Conservation Service, C-NPRBS Data.

In the coastal areas some wet soils have been drained to a degree suitable for the crop grown or are being used for purposes that do not require drainage. Based on available data, it has been estimated that about 30,000 acres have been drained in this subregion. Drainage practices accomplished through 1966 are shown in table 426.

Table 426 - Drainage Practices Applied to Cropland, Subregion 10, 1966

Practices	Units	Oregon	Washington	Total
Conduits and Ditches	Miles	1,229	277	1,506
Structures	No.	378	23	401

Source: Soil Conservation Service Data.

Over half of the excessively wet soils need to be drained for best production under present use. Most of the land has been drained with tile. Deeper outlets have been required in some locations. Besides increasing production, drainage also has increased the number and variety of crops that can be grown.

Tidal waters and seepage from higher lands are common problems. These areas can be drained by using an interceptor tile or ditch. Random or pattern type tile systems are used to drain many areas. There are many dikes, tidegates, flood gates, pumping plants, drainage ditches, and tile lines that provide protection, but most of the land and crops would benefit from additional protection.

Interior valley streams which developed under good drainage have coarser textured soils near the stream and finer textured soils furthest from the stream. Drainage problems occur when excess water becomes perched or when subsurface water from higher areas is diked by the fine textured soils. Almost 156,000 feet of open drain ditch and tile drains have been installed in the basin. About half of this was installed as relief and the other half as interceptor drains.

Bear Creek Valley of the Rogue is a braided stream and typical of valleys developed under mature drainage. The fine textured soils lie nearest the streams and coarser textured soils are located furthest from the streams and are usually in a slightly higher position.

Of the 32,800 acres of wet cropland in the Rogue Valley, 14,500 acres are in Bear Creek of the Rogue. As agriculture and irrigation developed, the drainage problem grew. New wet areas

appeared in some fields that had previously been dry. The water table rose until some orchards became nonproductive and were removed to make way for other crops.

Erosion and Sediment

There are over 32,000 acres of cropland that have been damaged by erosion. Of this, almost 22,000 acres are in the Rogue Valley. The extent of the soils in the cropland areas having an erosion potential are shown in table 427.

Table 427 - Cropland Areas with an Erosion Potential, by Capability Class, Subregion 10, 1966

Capability Class	Oregon	Washington	Total
	---------------1000 acres-------------		
II	66	3	69
III	119	14	133
IV	316	79	395
Total	501	96	597

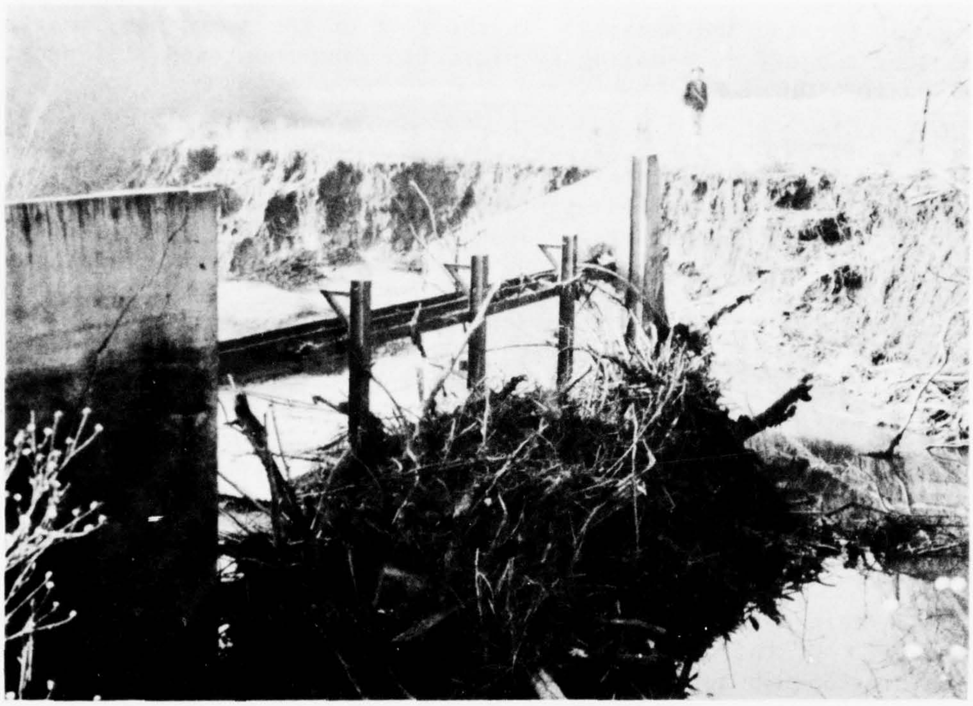
Source: Soil Conservation Service, C-NPRBS Data.

A large part of the work necessary to control erosion is being done through local Soil and Water Conservation Districts. Table 428 shows the total accomplishments through 1966.

Table 428 - Erosion Control Practices Applied on Cropland, Subregion 10, 1966

Practice	Units	Oregon	Washington	Total
Grade Stabilization Structures	No.	31	2	33
Diversions and Terraces	Miles	28.0	0	28.0
Ditch Bank Seeding	Miles	7.0	0	7.0
Crop Residue Use	1000 Acs.	31.6	8.0	39.6
Grassed Waterway	1000 Acs.	0.4	0.3	0.7
Conservation Cropping System	1000 Acs.	68.4	51.4	119.8
Pasture and Hayland Planting	1000 Acs.	91.1	3.8	94.9

Source: Soil Conservation Service Data.



Debris clogged structure causes flood waters to cut new channel around drop. (SCS 0-1338-4)

Land damage from erosion, leaching, scour, and deposition is significant but very difficult to evaluate and is probably inadequately appraised in the coastal areas. Much of the arable land is effectively protected from rill and sheet erosion by perennial sod-forming crops.

Wind erosion on agricultural land is not a serious problem at present, because most cultivated land is either wet, has fine-textured soils which resist wind action, or is protected from wind by crops, trees, or hills. However, wind erosion would be serious on the marine terrace soils near the ocean if they were cleared and cultivated.

As previously noted, 70 percent of the cropland with an active erosion problem is in the Rogue subbasin. Roughly 10 percent of the erosion problem is due to flooding of cropland by streams and rivers. Flood plain scour occurs when croplands are unprotected or when velocities of the flood waters exceed those that are safe for protected soils. Another 15 percent of the erosion problem is from poor irrigation practices. A large number of farmers still flood irrigate erodible soils or steep slopes. The principal erosion problem occurs because of sand-size quartzitic grit in the soil. Soils formed in residuum or colluvium from the Applegate formation, mostly diorites and granodiorites, are highly erodible unless

properly treated and managed. In the rest of the subregion, most of the land subject to flooding is protected from sheet and rill erosion by sod-forming crops.

Considerable land is lost through streambank erosion in both the coastal areas and interior basins. Damage is usually most prevalent along the swifter protions of the streams, but the problem also exists along the larger, slower protions. Bank protection by rock riprap and by vegetation and removal of gravel bars, drift, and brush is needed. There is particular need to evaluate stream channel characteristics carefully in order to recommend reservoir releases that will prevent further aggravation of bank erosion. Channel enlargement and clearance is sometimes required to accommodate high flows. Stream channel work is usually most beneficial when a complete unit of channel is improved in a single coordinated project rather than by piecemeal work by individual landowners.

Flooding

There are almost 223,000 acres of cropland subject to frequent flooding. Of this, 168,000 acres are in the coastal area and the remaining 55,000 acres are in the Rogue, Umpqua, and Chehalis valleys.

Debris left on cropland following a flood. Removal cost and erosion damages could make the land unfeasible for future crop production. (SCS 0-1338-8)

Some work has been done on flood control work through local Soil and Water Conservation Districts. Table 429 shows the accomplishments through 1966.

Table 429 - Flood Protection Measures Applied on Cropland Areas, Subregion 10, 1966

Practice	Units	Oregon	Washington	Total
Stream Channel Improvements	Miles	222	89	311
Streambank Protection	Miles	102	20	122
Stream Channel Stabilization	Miles	4	Tr.	4
Dikes and Levees	Miles	72	42	114

Source: Soil Conservation Service Data.

There are two main sources of floodwaters in this basin: the rapid runoff from rain and snow, and tidal action of the ocean. Floods are most likely to occur during November to March in the heavy precipitation period, but may occur as early as September or as late as May. Fairly continuous rainfall during this period saturates the soil and causes heavy runoff from the steep, upper portions of the watersheds.

Inundation, caused by ocean tidal waters holding up streamflow, is common along the lower parts of the coastal watersheds. Most damage occurs when abnormally high tides and severe winter storms coincide. Dikes and tidegates have been installed to protect many areas, but some of these structures are inadequate or in need of repair. Many other areas are entirely without such protection.

Agricultural damages, consisting primarily of crop and property losses, account for much of the total evaluated flood damage. Because of serious drainage problems and frequent flooding, many acres of land have never been developed for cropland. A few floods reach land that has been left bare after row crops or hay and pasture land that is being reseeded. Sediment and debris damage fields, drain ditches, stream beds, and harbors. Total average annual flood damages are estimated in Appendix VII, Flood Control, to be nearly $11.3 million.

Forest Land

Forests cover 13.8 million acres or about 92 percent of the total land area in the subregion. About 52 percent is in public ownership and 48 percent is private. Of this, 93 percent is considered commercial forest land, 7 percent noncommercial.

The commercial area currently supports over 260 billion board feet of merchantable timber; 63 percent on public land, 37 percent on private. The subregion ranks first in the region in volume of timber harvested, averaging 2 billion board feet annually. Nearly 6.4 billion board feet were cut in 1964. This furnishes the raw material for the subregion's major industry, accounting for 83 percent of its manufacturing employment.

Since most of the subregion is forested, the majority of the runoff, 93 percent, originates here. The total urban population is dependent, for the most part, on these watersheds for their domestic water. Irrigation depletions, amounting to over 300,000 acre-feet annually, are produced mainly on these same areas.

The forest lands are generally in a good condition and have low overall sediment yields. But, because the subregion is the source of most of the streamflow, it is also the source of much of the stream's sediment loads. This is largely due to glacial activity in the barren and alpine areas, heavy winter runoff, and the largest timber harvest program in the region. About 92 percent of the subregion sediment yield comes from these areas, an average of about 2,200 acre-feet per year (table 430).

Table 430 - Present Sediment Yield, Forest Land, Subregion 10

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield Acre-feet Per Square Mile	Annual Sediment Yield Total Acre-feet	Percent
Very low	1,294.7	9	0.02 - 0.1	40	2
Low	11,328.8	82	0.1 - 0.2	1,770	81
Medium	1,205.1	9	0.2 - 0.5	377	17
High	--	--	0.5 - 1.5	--	--
Very high	--	--	1.5 - 4.0	--	--
Total	13,828.6	100		2,187	100

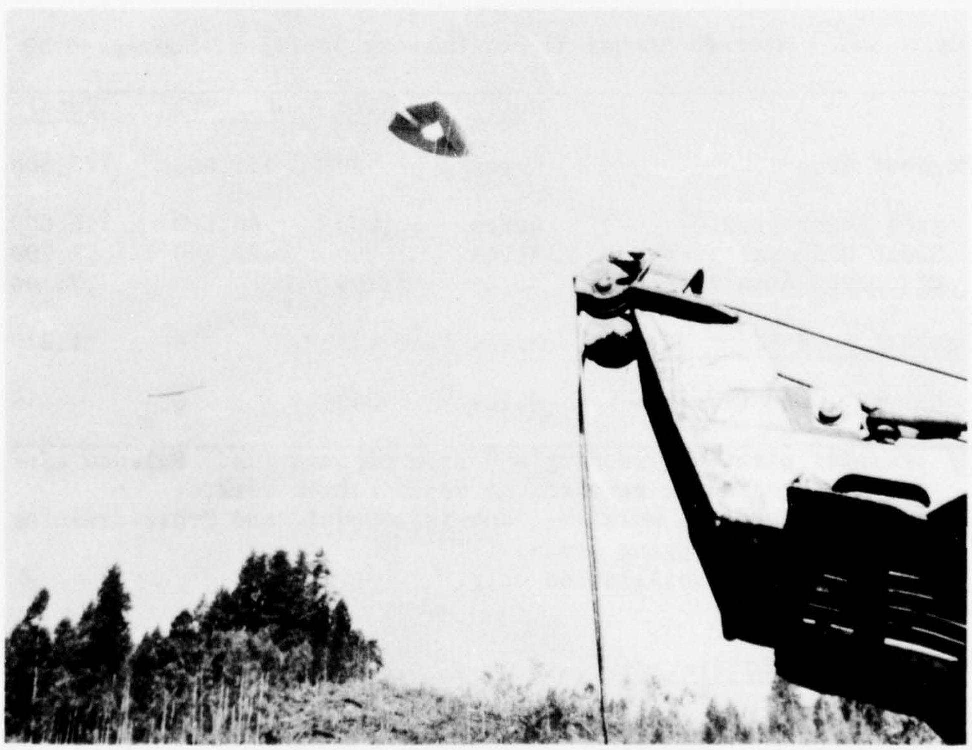
Source: Derived from figures 61 and 62.

Almost 82 percent of the forest land is in the low yield category. Sediment from these areas results principally from natural or geologic erosion. The sediment load in the other areas has been increased through land use activity. While some watershed rehabilitation work has started to improve water quality from previously damaged areas, emphasis has been on preventing a further reduction in existing water quality from the current use areas.

Watershed Protection

In this subregion, it is also the general practice to harvest the timber in clearcut blocks or units. The cable system is used throughout. Timber is often removed from small cutting areas with mobile yarders, operating from fixed points along roads. Salvage and thinning products are logged by cable systems or tractors, depending on steepness of terrain. In all cases, extensive logging road systems are required.

Forest managers are alert to the need for more suitable equipment to log much of the coastal area without disturbing the soil or developing extensive road networks. This is particularly true in areas with steep slopes and soil conditions that preclude road construction. Two systems hold promise. One, balloon logging, is a method whereby a helium-filled balloon supports the cable system, keeping logs free of the ground. Balloon logging is in the experimental stage of operation and may prove to be very successful. Another system, known as the skyline crane, uses gravity-powered logging equipment to keep logs free of the ground. It is being used with varying success. Both systems are still in the experimental stage, although the skyline system has been used successfully in several areas.



Balloon logging, a cable-logging system that removes logs completely free from the ground. Such a system permits timber removal from steep slopes with very little disturbance to the soil and water resources. (Forest Service)

On most forest lands, tractor trails and firelines in the harvested areas are cross-drained to reduce erosion. Some of the more critical areas are also seeded to grass. This seeding has the combined effect of stabilizing disturbed soil and furnishing additional browse for wildlife.

Nearly all temporary roads are also cross-drained to prevent gullying and retard runoff. Cull logs and other debris must be removed from major watercourses and steep draws. This prevents subsequent erosion which can damage downstream fish habitat and other improvements.

Most main-line log haul roads are gravel surfaced and have permanent culverts. In many cases, particularly at the crossing points on anadromous fish streams, excavated material is end-hauled and deposited away from the water areas. The seeding of exposed cutbank and fill slopes is also used to prevent movement of sediment from bare slopes.

Reforestation measures include both planting and aerial seeding. Advance reproduction is protected from both burning and logging activity by on-the-ground administration. Harvest activities and protective works are summarized in table 431.

Table 431 - Average Annual Timber Harvest Activity, Subregion 10

	Unit	Public	Private	Total
Harvest Area	Acres	62,500	111,000	173,500
Area Reforested 1/	Acres	50,000	66,600	116,600
Slash Disposal Area	Acres	31,500	22,200	53,700
Disturbed Area Treated 2/	Acres	3,100	--	3,100
Harvest Road Required	Miles	435	775	1,210
Harvest Road Treated 3/	Miles	240	75	315

1/ Includes planting, seeding and site preparation. Balance adequately stocked or requires no regeneration work.
2/ Includes seeding, mulching, debris removal, and cross-draining skidroads and logging areas.
3/ Cut and fill stabilization only.

Watershed Rehabilitation

Seventeen percent of the sediment produced from forest land in the subregion comes from the 9 percent in the medium-yield condition (table 430). It is in these areas that timber activities

Hand seeding of grasses and forbs on a bulldozer-constructed fireline around a timber harvest unit in the Coastal Subregion, Washington portion. This practice stabilizes the soil and furnishes feed for wildlife. (Forest Service)

in the past have added sediment to the natural base load, creating local erosion problems. Most of it is from water movement down abandoned roads, across old burns and logged-off areas, and from streambank cutting. These are places where past watershed protection measures were limited. It is on these areas, particularly in public ownership, that rehabilitation work is being accomplished as fast as funds permit (table 432).

Table 432 - Average Annual Accomplishment, Watershed Rehabilitation Practices on Public Forest Land, Subregion 10

Practice	Unit	National Forest 1/	BLM	Indian Lands	State Lands
Sheet Erosion Control	Ac.	350	350	--	5
Gully Stabilization	Mi.	12	--	--	--
Stream Clearance & Stabilization	Mi.	30	25	2	11
Existing Road & Trail Rehabilitation 2/	Mi.	35	15	2	10
Reservoir Protection	Ac.	--	--	--	--

1/ Average of period 1964-66
2/ Includes abandoned roads.
Source: Data furnished by agency as listed.

Most of the major industrial tree-farm owners do a good to excellent job of production management on their forest lands. This type of management affords good watershed protection on most of their operating areas. These companies' objectives are production oriented, however; and it is difficult to evaluate the benefits in terms of rehabilitation effectiveness. Work on the small private holdings has been done mostly in connection with the Department of Agriculture's Agricultural Conservation Program. Here, as in other subregions, this program has had some watershed rehabilitation benefit although the work is normally undertaken for other purposes.

Water Yield Improvement

Some beneficial increase of streamflow is obtained through the normal timber harvest program when the old-growth timber is being removed. Some also results from timber stand cultural practices such as thinnings and release. These benefits are minor, however, and are not planned to modify water yields or the timing of downstream flows. No specific water yield improvement programs are currently underway.

Rangeland

The 169,000 acres of rangeland in Subregion 10 consist mainly of small parcels of grass or brush land intermingled with valley bottom cropland and higher elevation forest land. Two-thirds of this land, or 106,800 acres, are in public ownership (including 94,800 acres of Federal land), located primarily in the southern part of the subregion. In addition to wildlife use, it provides supplemental livestock feed requirements to round out the holdings of farm and ranch operators for better balanced agricultural enterprises.

Rangeland use has an influence on adjacent and downstream cropland and urban uses both in terms of water yields and of flood and debris damage. In coastal areas, heavy precipitation and relatively high runoff in the winter and spring result in erosion of some range areas when the cover has been disturbed or overgrazed. In the Rogue and Umpqua basins, a heavy snowpack followed by torrential rains occasionally causes high runoff and excessive streamflows. Rangeland and downstream areas have erosion damage due mostly to flooding. Around the Bear Creek and Grants Pass areas, sheet and rill erosion occurs on unprotected range soils. Although watershed conditions have been improved in recent years, more than half of the range was still poor condition in 1966 with deficient vegetative cover and insufficient water holding capacity (present rangeland condition is shown on table 433). The total annual sediment yield from rangeland is 37 acre-feet (table 434) with two-thirds of the land producing an average of 0.15 acre-feet per square mile.

Table 433 - Rangeland Condition and Capacity, Subregion 10, 1966

Range Type and Condition	Ownership					
	Public		Private		Total	
	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)
Grassland						
Good	.9	.4	.3	.1	1.2	.5
Fair	15.5	2.6	2.5	.4	18.0	3.0
Poor	32.1	1.9	17.8	1.0	49.9	2.9
Seeded Range 1/	6.5	2.1	25.7	8.6	32.2	10.7
Total	55.0	7.0	46.3	10.1	101.3	17.1
Sagebrush						
Good	--	--	--	--	--	--
Fair	--	--	--	--	--	--
Poor	--	--	--	--	--	--
Total	--	--	--	--	--	--
Other Brush						
Good	7.3	1.8	.6	.2	7.9	2.0
Fair	17.5	2.1	2.1	.2	19.6	2.3
Poor	27.0	1.0	12.8	.5	39.8	1.5
Total	51.8	4.9	15.5	.9	67.3	5.8
Total						
Good 2/	14.7	4.3	26.6	8.9	41.3	13.2
Fair	33.0	4.7	4.6	.6	37.6	5.3
Poor	59.1	2.9	30.6	1.5	89.7	4.4
Grand Total	106.8	11.9	61.8	11.0	168.6	22.9
Percent Distribution	63.3	51.8	36.7	48.2	100.0	100.0
Average AC/AUM	9.0		5.6		7.4	

1/ Seeded range acreage was combined with good and fair condition grassland in Appendix IV.
2/ Includes seeded range.
Source: Rangeland narrative, C-NP Appendix IV, Subregion 10. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

Table 434 - Sediment Yield from Rangeland, Subregion 10, 1966

Sediment Yield Categories 1/	Grassland	Shrubs	Total	Percent
	Rangeland Acreage (1,000 Acres)			
Very Low	28.1	18.6	46.7	28
Low	65.1	43.3	108.4	64
Medium	8.1	5.4	13.5	8
High	--	--	--	--
Very High	--	--	--	--
Total	101.3	67.3	168.6	100
	Annual Sediment Yield (Acre-Feet)			
Very Low	3	2	5	12
Low	15	10	25	68
Medium	4	3	7	20
High	--	--	--	--
Very High	--	--	--	--
Total	22	15	37	100

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet, respectively.
Source: Derived from figures 61 and 62.

Measures and Practices for Watershed Protection

Table 435 shows accomplishments in rangeland watershed protection and improvement through 1965. Cover improvement and soil stabilization practices were applied on about 59,300 acres of rangeland. An estimated 32,000 acres were revegetated primarily by grass seeding, with about 50 percent of this effort for improved watershed conditions. On 58,000 acres, livestock grazing was adjusted to the grazing capacity of the land to achieve proper grazing use through better livestock distribution. Construction of about 400 miles of control fences and development of 350 water facilities for livestock and game helped to make this adjustment for increased vegetative cover and improved water holding capacity of some areas, and aided in reduction of erosion. The development of 100 ponds and small reservoirs and about 90 check dams helped conserve winter and early season runoff for subsequent livestock and wildlife use and provided flood and debris control in periods of excessive runoff and streamflow.

Table 435 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Up to 1966, Subregion 10 1/

Measures & Practices	Units	Land Ownership			Watershed Purposes 2/			
		Public 3/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	6,500	25,700	32,200	x	x	x	x
Brush Control	Acres	6,400	15,400	21,800	-	-	x	-
Weed Control	Acres	2,300	1,400	3,700	-	-	x	-
Fertilizing	Acres	125	75	200	-	-	x	-
Waterspreading	Acres	-	50	50	-	x	x	-
Irrigation	Acres	200	100	300	-	x	x	x
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	300	100	400	-	x	x	-
Reducing Excessive Grazing Use	Acres	36,900	21,400	58,300	-	-	x	-
Livestock & Game Water Facilities	Number	40	300	340	-	x	-	-
Water Control Structures								
Ponds & Small Reservoirs	Number	65	35	100	x	x	x	x
	Acre Ft.	50	30	80	x	x	x	x
Check Dams (Gully Plugs)	Number	25	65	90	-	x	x	x
	Cu. Yds.	6,100	14,900	21,000	-	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.

Other Land

Other land covers about 472,200 acres, which is 3 percent of the land area. The acreages of other land categories are shown in table 536.

Barren land, composed mostly of beaches and sand dunes, is the largest segment of other lands. Beach erosion and active dunes are the most serious problem of other lands along the coastal areas. Considerable work has been done on dune stabilization by landowners,

Table 436 - Other Land Areas, Subregion 10

	Oregon	Washington	Total	Percent
	--------1000 acres--------			
Small Water	60.7	6.6	67.3	14
Roads and Railroads	43.1	20.9	64.0	14
Farmsteads, Urban, Industrial and Miscellaneous	78.7	45.6	124.3	26
Barren Land	110.4	106.2	216.6	46
Total	292.9	179.3	472.2	100

Source: Appendix IV, Land and Mineral Resources.

units of Government, and land management agencies through the local Soil and Water Conservation Districts. One of the many active groups has been the Warrenton Dune Soil and Water Conservation District. The material below is an excerpt from the District's 1966 Annual Report:

> "In 1935, the 3,000 acres of sand dunes in the northwest corner of Clatsop County were on the move--covering fertile pasture, filling in lakes, covering forests, and hindering navigation on the Columbia River.
>
> "The first work was started in 1935 by the Civilian Conservation Crops, and continued by the Warrenton Dune Soil and Water Conservation District. Beachgrass planting was started as the first and most successful method of stilling the shifting sand. Twenty-three miles of picket fences were built to form a protective ridge so the beach grasses could get a better start.
>
> "In the less erosive areas, native grasses and legumes were seeded in the beachgrass, making good food for wildlife, as the beachgrass is nonpalatable to livestock.
>
> "The first step was the use of woody plants, pine being the best suited. Species from all over the world were tried. The local shore pine proved to be the best all-around one that was used.
>
> "Scotch broom and shore pine serve best in supporting roles and were planted to provide a lasting cover after the sand was halted by beachgrass planting. In tree and shrub plantings, survival was very high and growth excellent.
>
> "Success achieved with the Warrenton Dunes has attracted attention from countries all over the world. Visitors come to study the systems that were, and are, being used."

Coastal sand dunes damage permanent ground cover through their relentless movement inland. (Forest Service)

The Forest Service, Bureau of Land Management, and Soil Conservation Service have been stabilizing dunes from south of Reedsport, Oregon, to north of Florence, Oregon, in the vicinity of the Siuslaw and Umpqua rivers. Using improved techniques and practices, nearly 2,500 acres have been stabilized since work was undertaken in these areas.

In addition to the dune erosion problem, severe beach erosion is occurring at points all along the coast, such as Toke Point on the northern shore of Willapa Bay. The Point is about 5 miles east of the mouth of Willapa Bay. Approximately 7,000 feet of the southern shore of Toke Point are in an active state of erosion. The shoreline has receded at an average rate of 12 feet each year for the past 50 years, and has resulted in the loss of 17 city blocks of developed property. Storm waves threaten to breach the southern tip of Toke Point and form a tidal slough which would be enlarged gradually by each subsequent storm. Breaching would result in the loss of a small boat basin, U. S. Coast Guard Facilities, seven plotted city blocks, and approximately 10 acres of land. Ultimately, the area north of Toke Point would be exposed to wave action.

At Cape Shoalwater, located to the north of the entrance channel to Willapa Bay, the natural deepwater entrance channel has been shifting northward resulting in extensive beach erosion. The erosion involves three main processes: (a) Littoral drift, (b) action of wind-waves and swell, and (c) hydraulic action of tidal flow. The hydraulic action appears to be the primary cause of the northward migration of the channel. Periodic surveys, from 1890 to 1965, show that the entrance channel and Cape Shoalwater shoreline had moved northward about 9,000 feet by 1955 and another 1,500 feet by 1965. This erosion has destroyed valuable beach recreational areas, homes, and business property. Attempts at erosion control in the Cape Shoalwater area have been limited to a few groins consisting of piling, reinforced by old automobile bodies and tires. They were installed in 1966 by private interests without engineering studies and have not proven to be effective. However, private interests have been successful in forestalling further erosion on a short stretch of privately owned beaches.

Water is the predominant problem that concerns urban and municipal areas. This problem includes flooding, supply, and quality. Of the 124,000 acres classed as farmsteads, urban, industrial, and miscellaneous (airports and golf courses), over 16,900 acres are subject to flooding. An inventory, a part of this study, indicates that a number of these areas have water supply and quality problems. Many of the watershed problems occurring on other land result from land use activities on upstream cropland and forest areas. Watershed measures and practices accomplished in these areas (as discussed in previous sections) have been beneficial in reducing erosion and flood damage to other land. One example of this is the upland watershed treatment on forest land. Sediment control practices applied on forest areas have reduced the siltation problem on the estuary oyster beds.

FUTURE NEEDS

Producing wood fiber is the major industry in the coastal subregion. This industry, along with fishing and recreation, has set the pattern for development.

Within the next 50 years, the timber industry is expected to remain the dominant industry. However, agriculture is expected to change somewhat. Total on-the-farm population is projected to decrease from 27,000 to just under 11,000, while the average cropland area per farm unit should increase from 49 acres to about 120 acres.

Some shift in land use can be expected to occur between cropland, forest land, range, and other land. The projected change in cover and land use is shown in table 437. More intensive watershed planning will be needed to meet future needs.

Table 437 - Projected Change in Cover and Land Use, Subregion 10

Item	1966	1980	2000	2020
		(1,000 acres)		
Cropland	584.8	472.0	421.0	370.0
Forest Land	13,828.6	13,795.0	13,747.0	13,700.0
Rangeland	168.6	160.0	150.0	140.0
Other Land	472.2	587.0	676.2	763.8
Total	15,054.2	15,014.0	14,994.2	14,973.8

Source: Soil Conservation Service, C-NPRBS Data.

Cropland

About 192,000 acres of cropland have a wetness problem, 32,200 acres have an active erosion problem, over 223,000 acres are subjected to frequent flooding, and about 27,000 acres of irrigated cropland do not have a full season supply of irrigation water. A large percentage of these problems will have to be corrected if cropland is to meet future needs. This is especially true since the demand for agricultural products will increase but the area of cropland will decrease. The projected cropland trend is shown in table 438.

Table 438 - Projected Trends in Dry and Irrigated Cropland, Subregion 10

Cropland	1966	1980	2000	2020
		(1,000 acres)		
Dry Farmed	409.6	202.0	137.0	54.0
Irrigated[1/]	175.2	270.0	284.0	316.0
Total	584.8	472.0	421.0	370.0

1/ Approximately 97 percent of the projections shown in Appendix IX, Irrigation.

Source: Soil Conservation Service, C-NPRBS Data.

Water Conservation

The projected increases in agricultural production will require an increase of an estimated 140,800 acres in irrigated land. In addition, water needs to be developed for those areas that do not have a full season supply, which is about 15 percent of the irrigated cropland.

The increase in irrigated cropland and supplemental water supplies will increase the demand for agricultural water supplies almost 20 percent. Table 439 shows the projected cumulative trend in the method of irrigation on cropland.

Table 439 - Projected Cumulative Trend in the Method of Irrigation on Cropland, Subregion 10

Item	1966	1980	2000	2020
		(1,000 acres)		
Sprinkler Systems	66.5	150.2	201.9	251.7
Flood Systems	108.7	99.8	82.1	64.3
Total Area	175.2	250.0	284.0	316.0

Source: Soil Conservation Service, C-NPRBS Data.

Drainage

About 192,000 acres of cropland have a wetness problem. Increased irrigation and a shift in cropland areas are expected to increase the drainage problem by over 14 percent or just over 20,000 acres. Almost 70 percent of this 242,000 acres must be drained by 2020 to meet projected food and fiber needs (table 440).

Table 440 - Cumulative Cropland Areas Needing Drainage, Subregion 10

Item	1966	1980	2000	2020
		(1,000 acres)		
Wet Area	192.0	226.3	234.0	241.6
Projected Accomplishment	32.2	97.5	135.3	174.8
Remaining	159.8	128.8	98.7	66.8

Source: Soil Conservation Service, C-NPRBS Data.

Erosion and Sedimentation

Almost 600,000 acres of cropland have an erosion potential. At the present time, ground cover and use are such that erosion is effectively controlled on all except 32,000 acres. Almost 70 percent is in the Rogue Basin. The remaining problem areas are fairly well scattered over the rest of the subregion. Shifts in cropland areas are expected to increase the cropland areas with an erosion problem by about 9,000 acres by the year 2020 (table 441).

Table 441 - Cumulative Cropland Areas Needing Erosion Control, Subregion 10

Item	1966	1980	2000	2020
		(1,000 acres)		
Erosion Potential	597.0	599.5	602.8	606.0
Projected Accomplishment	564.8	573.9	586.0	597.9
Remaining	32.2	25.6	16.8	8.1

Source: Soil Conservation Service, C-NPRBS Data.

Flooding

Of the 223,000 acres of cropland that are subject to frequent flooding, 75 percent is in the coastal areas. The other 25 percent is in the Rogue, Umpqua, and Chehalis valleys.

In the coastal areas, floods on the flood plains of streams and rivers can be controlled through normal practices such as retention and channel enlargement. However, the type of floods that occurs on the built-up tidal plains make it almost impossible to completely control within the realm of economic feasibility. Floods, on the tidal plains, are controlled to some extent by diking and the use of tidegates to outlet small streams and drainage ditches. Frequent and extensive flooding occurs when high tides and southwest storms coincide, rendering tidegates inoperable.

In these areas, annual floods are expected and cropping patterns are adjusted to fit the conditions. Flood control work is expected to continue much as it has been in the past. Dikes will be built or improved, channels will be enlarged, and tidegates will be installed. Some flood water retention or diversion structures will probably be installed to protect high value properties.

Soil erosion is not usually a problem from tidal plain floods. For this reason, crops other than grasses and legumes can be grown with the use of winter cover crops to prevent soil puddling.

In the interior valleys of the Rogue, Umpqua, and Chehalis rivers, floods are very damaging but can be controlled. Much of the control is expected by 2020. For a more complete discussion of this see Appendix VII, Flood Control.

Forest Land

The forest industries of the subregion will require an estimated 950 million cubic feet of raw material per year by the year 2020. This volume will be produced principally on the 12.7 million acres of commercial forest land projected to be in production by the year 2020. This can be expressed as a need for 75 cubic feet per acre. This amounts to a reduction of about 5 cubic feet per acre when compared to the present consumption rate of 80 cubic feet. Although the consumptive demand will decrease, it will still exceed the present growth rate by more than 10 cubic feet per acre. This, in itself, points out the need for more intensive forest management practices on the commercial forest area. The increased needs cannot continue to be met by raw material imports from other subregions as demands in these areas are projected to increase by 2020 also. Improved management practices such as thinnings, fertilization, selection of improved tree species, and more complete utilization of the present raw material are necessary to increase forest land yields.

Potential erosion hazard and sediment yield have been determined for the forest land. It is depicted on figure 63 and table 442. This potential represents yields that could be expected if watershed protection practices are ignored. Yields could be expected to increase nearly 3-1/2 times.

Table 442 - Potential Sediment Yield without Protective Measures, Forest Land, Subregion 10

Soil Loss Category	Acres (1,000)	Percent	Acre-feet per Square Mile per Year	Total Acre-feet per Year
Low	5,729.3	41	less than 0.2	895
Medium	6,084.6	44	0.2 - 1.5	1,901
High	2,014.7	15	more than 1.5	4,722
Total	13,828.6	100		7,518

Source: Soil Survey Data & Interpretations, U.S.D.A. Forest Service, Region 6.

Watershed Protection

Some present indications point toward a reduction or leveling off in demand on the subregion's forest lands for raw material by 2020, mainly because the forest lands, at this time, will be at their full production potential. This leveling off will follow the conversion of the old-growth stands to second-growth size classes.

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POTENTIAL EROSION HAZARD FOREST LAND

COASTAL, SUBREGION 10

1968

FIGURE 63

However, present levels of logging and road construction will continue until this period is reached. Table 443 lists the cumulative future timber harvest and road program necessary to reach this point. Also included is the estimated acreage of ground disturbed during these operations that will require watershed protection practices such as seeding, mulching, and restoring a protective ground cover.

Table 443 - Projected Cumulative Timber Harvest Activity, Forest Land, Subregion 10 1/

	Unit	1980	2000	2020
Timber Harvest Area	Ac.	2,639,000	4,590,000	6,442,000
Road Construction	Mi.	18,500	32,100	45,100
Ground Disturbance 2/	Ac.	317,000	551,000	784,000

1/ Based on the 1965 level of timber requirements.
2/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.

The data in the table indicate that by the year 2020, the forest ground cover will be severely disturbed on nearly 800,000 acres of forest land. This is the area from which the potential sediment would be produced. With over 6.5 million acres coming under harvest during this period, accelerated protection measures, stronger utilization controls on public land, and additional technical assistance for the private landowner are all needed.

Watershed Rehabilitation

Future demands for the subregion's water yields will require improved quality through reduced sediment loads, particularly for domestic and industrial purposes.

Watershed rehabilitation work is still required on much of the 1.2 million acres in the medium yield category listed on table 430. These are the lands adding considerable silt from previous land use activities; tracts of old logging, abandoned roads, logging debris in watercourses, and old burns.

Water Yield Improvement

Timing of water yield is probably more important than increases in water yield in this subregion. Presently 59 million acre-feet or 93 percent of the subregion water yield originates on the forested lands.

The Water Retention Capacity Map (figure 64) and table 444 indicate the potential ground-water storage capacity of the forest soils of the subregion. These soils have a potential storage capacity of nearly 20 million acre-feet. There is a possibility here of using this ground-water reservoir for delaying peak flows, allowing water to enter the tributary streams during later low stages. This could be best accomplished by water spreading and other infiltration improvement practices. Since these peak flows occur prior to the growing season, this storage is also available for irrigation supplies by maintaining pumping levels in downstream wells.

Table 444 - Water Retention Capacity, Forest Soils, Subregion 10

Retention Class	Acres (1,000)	Percent	Acre-feet per Square Mile	Total Acre-feet
Low	4,010.3	29	less than 300	1,800,000
Medium	8,988.8	65	300 - 1,500	12,600,000
High	829.5	6	more than 1,500	5,200,000
Total	13,828.6	100		19,600,000

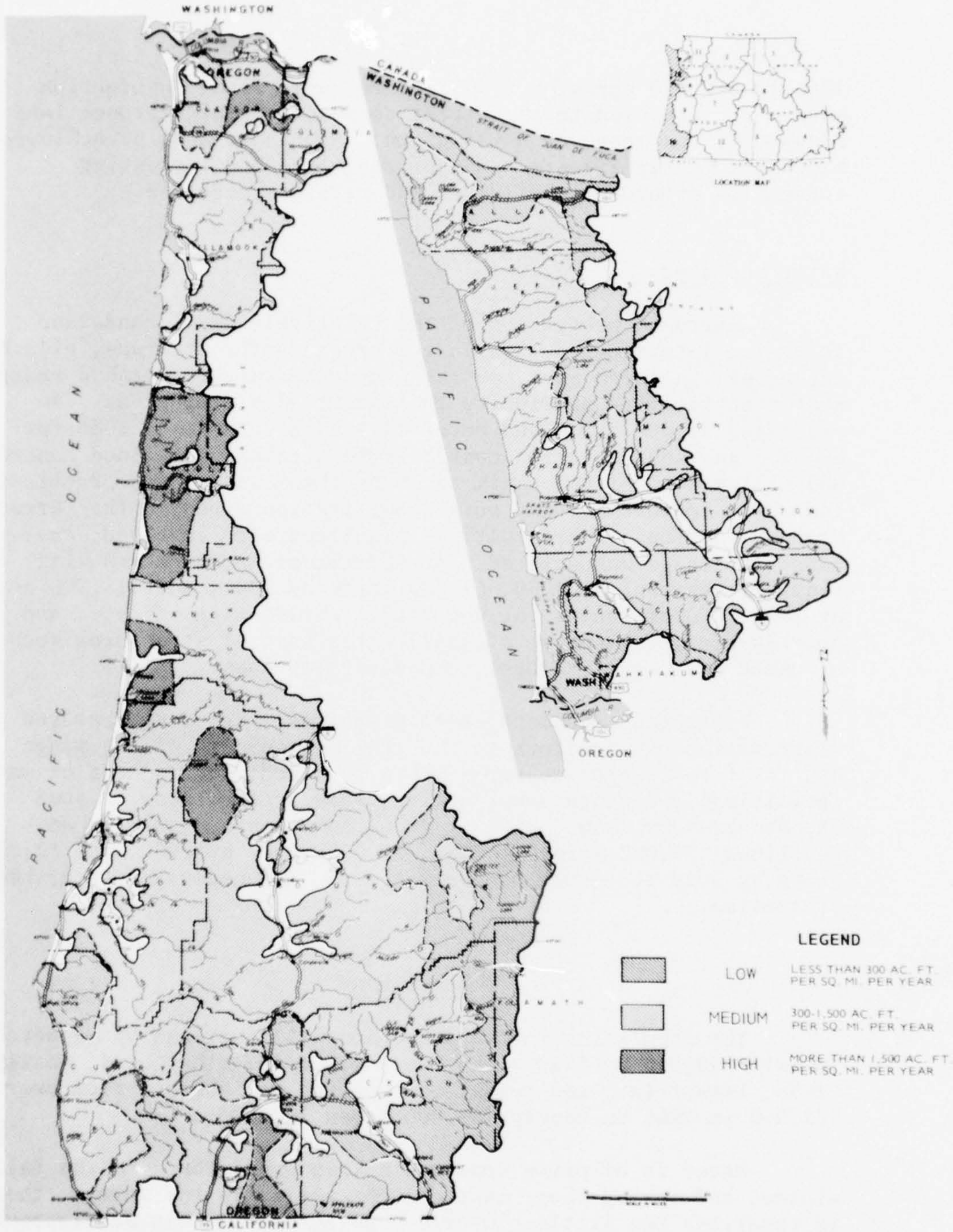
Source: Soil Survey Data & Interpretations, USDA Forest Service, Region 6.

Rangeland

Erosion and sedimentation is a significant problem on about 39,000 acres of rangeland in this subregion. Some 13,500 acres produce an average annual sediment yield of about .35 acre-feet per square mile, while the remainder yields about .2 acre-feet. These areas account for nearly 40 percent of the total 37 acre-feet annual rangeland sediment yield. Flood problems exist on about 17,200 acres of rangeland, drainage problems exist on scattered low lying areas, and there is need for improved water yield through better range use.

Projected Use of Range Resources

The relatively small parcels of rangeland in this area will continue to provide an important supplemental source of livestock feed for farm and ranch enterprises. Subregional demand for beef and veal production is projected to increase from 66.8 million pounds in 1964 to 123.7 million pounds or 85 percent by 2020. Sheep and lamb production is expected to increase from 11.5 million pounds in 1964 to 29.9 million pounds in 2020. (3) Although rangeland acreage is projected to decline from 169,000 acres in



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WATER RETENTION CAPACITY FOREST LAND

COASTAL, SUBREGION 10

1968

FIGURE 64

1966 to 140,000 acres by 2020, future range forage production should be increased to the extent commensurate with proper land management and resource utilization. A balance must be achieved between domestic livestock use of rangeland and increasing recreation demands for wildlife and related range use.

Watershed Needs

Watershed protection of the relatively small rangeland acreages, intermingled with larger crop and forest areas, will be dependent, in large part, on the manner in which watershed management practices are applied to the larger adjoining areas. An estimated 29,000 acres had received land treatment by 1966 for erosion and sedimentation control with accompanying flood control and drainage benefits. This includes the measures and practices for cover improvement and soil stabilization given in the "Present Status" section. Where multiple practices were involved, overlapping acreage was deleted. An additional 18,000 acres will require treatment by 1980, 61,000 acres by 2000, and 115,000 acres by 2020. Future needs include road stabilization efforts, and construction of a number of small water control structures such as check dams (gully plugs), and diversion dams.

Protection and management practices, including improved distribution of livestock to the grazing capacity of the range, special fire control measures where required, development of water facilities, and fence construction, were accomplished on some 58,300 acres by 1966. Similar requirements are needed on an additional 20,000 acres by 1980, 51,000 acres by 2000, and 82,000 acres by 2020 to insure proper range use and necessary watershed protection.

Other Land

The population in the subregion will increase by 85 percent to over 700,000 by 2020. The land needed for other uses, mostly urban, industrial, and roads, is expected to increase from over 472,000 in 1966 to nearly 765,000 acres in 2020.

Water is of prime concern in this subregion. In the fall, winter, and spring there is too much water. In the summer, there is sometimes too little. Over 16,900 acres of urban development are subject to flooding at the frequency of once in 5 to 10 years. In addition, roads, railroads, and industrial complexes sometimes flood. Flood protection, as discussed under cropland, forest land, and rangeland in this appendix and in C-NP Appendix VIII, Flood Control, will alleviate much of the flooding that occurs on other lands and will be an integral part of any plan to protect areas from floods.

Coastal dune control work is a continuing need. The following picture illustrates how shifting dunes move inland, destroying valuable cover as they go. This movement is responsible for costly road and improvement maintenance in the dune areas. Present inventories indicate some 2,500 acres require stabilization on public land and an estimated 5,000 acres on private land.

Present beach erosion problems are expected to continue through the three future time periods. In the past, only those localized areas of significant urban and recreation development have been studied and treated. More attention must be directed to the entire problem of beach erosion. Based on existing rates of erosion, some 40 miles of coastline in Oregon and Washington will need control by the year 2020.

Of the 209 watershed areas inventoried in the River Basins Study, 35 percent have a deficiency in rural domestic water part of the year, 16 percent in livestock water, 48 percent in municipal and industrial supplies, 86 percent need water for recreational, fish, and wildlife development, 78 percent needed water for water quality improvement.

MEANS TO SATISFY NEEDS

The land measures and watershed protection needs for optimum safe use of the cropland, forest, and range are translated into definite structural and nonstructural programs designed to improve the watershed condition. When these needs are satisfied, many of the watershed problems that presently result in damage to other areas will have been solved or reduced. The means to accomplish watershed protection and proper management are discussed in terms of individual items which are costed in 1969 dollars.

Watershed protection will be needed to control flood waters and sediment originating in the upper watersheds, which damage urban areas, rivers, and estuaries. If the lands in the watersheds are left bare through logging and agricultural practices, they are a threat to other areas. Erosion on cultivated land, logged forest land, and overgrazed pasture is the source for much sediment. Also, erosion of streambanks in the upper watersheds is the source of a large percent of the sediment yield. Sediment greatly reduces the attractiveness of rivers and estuaries for recreation, destroys the fishery resource, and damages urban areas.

A survey of the conservation needs of the subregion was made as a part of this study. The subregion was divided into 209 watershed areas to facilitate the study. Of these, 91 have a need for more intensive study and cooperative development under various Federal and State programs. The inventoried needs of these watersheds are shown in table 445 and located on figure 65.

Table 445 - Areas Needing Cooperative Conservation Development, Subregion 10

Target Date and State	No. of Watersheds	Flood Prevention	Erosion Control	Drainage	Irrigation New	Irrigation Supple-mental	Land Treatment
				(1,000 acres)			
1980							
Oregon	9	17.3	79.4	12.2	56.6	3.6	99.4
Washington	17	58.6	48.9	52.3	70.7	0.5	107.5
Total	26	75.9	128.3	64.5	127.3	4.1	206.9
No. Watersheds 1/	(26)	(26)	(17)	(25)	(26)	(2)	(26)
2000							
Oregon	11	14.1	72.9	24.0	38.8	16.7	100.9
Washington	20	55.7	91.1	78.5	42.2	-	169.6
Total	31	69.8	164.0	102.5	81.0	16.7	270.5
No. Watersheds	(31)	(31)	(22)	(30)	(26)	(4)	(31)
2020							
Oregon	9	8.2	16.1	5.0	29.4	2.6	26.9
Washington	25	10.7	54.1	9.4	5.6	-	64.8
Total	34	18.9	70.2	14.4	35.0	2.6	91.7
No. Watersheds	(34)	(24)	(16)	(25)	(20)	(3)	(28)

1/ Number of watersheds involved in each function by time periods.
Source: Soil Conservation Service, C-NPRBS Data.

Cropland

Agriculture has expanded from a small area to over 585,000 acres in the last 100 years. In the next 50 years, cropland is expected to decrease almost 140,000 acres. At the same time, the demand for agricultural products will grow. More intensive cropland use is anticipated with improved yields brought about by irrigation, drainage, improved strains, and better management.

This will require that the cropland be protected from flooding and erosion, improved through drainage and agronomic practices, and provided with irrigation water in the amounts and at the time needed. Total land area suitable for crop production is shown on table 446.

Table 446 - Land Areas Suitable for Crop Production
Subregion 10, 1966

Capability Class 1/	Oregon	Washington	Total	Percent
		1000 acres		
I	--	1.8	1.8	--
II	439.4	163.1	602.5	17
III	593.1	250.5	843.6	24
IV	1,482.9	636.2	2,119.1	59
Total	2,515.4	1,051.6	3,567.0	100

1/ Discussed, Appendix IV, Land and Minerals.
Source: Soil Conservation Service, C-NPRBS Data.

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AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

COASTAL, SUBREGION 10

1968

FIGURE 65

Water Conservation

Data show that over 3.5 million acres are in Capability Classes I through IV. Considering only soil characteristics, a great many additional areas could be irrigated. However, it is assumed that only a small portion of these soils can be economically irrigated in the foreseeable future.

Irrigated cropland is projected to increase from 175,000 acres to 316,000 acres by 2020. In addition, irrigation efficiencies should increase by about 30 percent during the same period. This will be brought about by improved irrigation systems and a shift in the method of applying water.

Practically all of the increase in irrigation is expected through the use of sprinklers. In addition, some cropland now being irrigated by flood irrigation is expected to change to sprinklers. Table 439 shows the change in methods of irrigation to be accomplished to meet the demand for improved efficiencies.

Increases in the irrigated area and shifts in the method of applying water will require an increase in the application rate of irrigation water management practices. Table 449 shows some of the practices needed to provide for the efficient use of irrigation water.

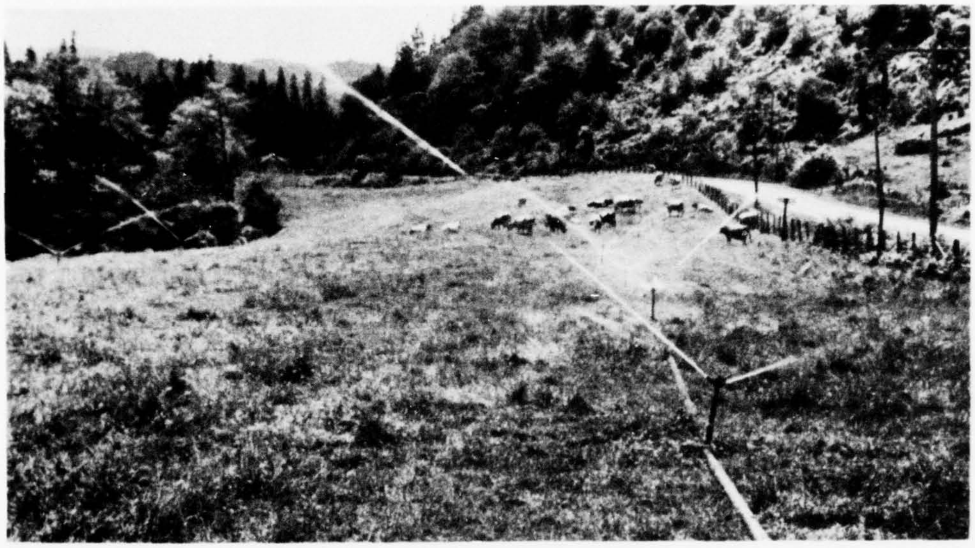
Table 447 - Cumulative Projected Practices for Irrigated Cropland, Subregion 10

Practice	Unit	1966	1980	2000	2020
Water Control Facilities	No.	1,934	2,490	3,610	4,730
Irrigation Water Conveyance	Miles	407	540	790	1,030
Water Storage	No.	92	115	145	180
Irrigation System, Surface	No.	2,787	2,560	2,100	1,650
Irrigation System, Sprinkler	No.	1,586	3,000	5,800	8,700
Land Shaping	1000 Acs.	37.6	45.2	65.4	85.7
Irrigation Water Mgt.	1000 Acs.	38.9	39.5	57.3	75.0

Source: Soil Conservation Service, C-NPRBS Data.

Along the coast irrigation is a marginal investment because of weather conditions. Some years are cool and damp, requiring little if any irrigation. Other years, the net irrigation requirement will be as high as 8 inches.

In spite of this, irrigation is projected to expand by 2020, because: (1) diversification into crops other than grasses and



Sprinkler irrigation improves efficiency of application, reduces labor cost, minimizes erosion, and greatly reduces transmission losses. (SCS ORE 45103)

legumes is just beginning and is expected to increase and (2) stockmen are expected to start using irrigation to insure a maximum carrying capacity on their pastures.

The Soil Conservation Service has made reconnaissance studies of some 218 sites along the Oregon Coast with a total potential storage capacity of over 914,000 acre-feet. All of the sites were studied for possible multiple use, which would include some combination of uses for irrigation, flood protection, recreation, and municipal and industrial supplies. Most of the storage for irrigation will have to be developed by groups of landowners. Diversions from streamflow will probably continue to be made by individuals or small groups.

Because of location of potential sites, land ownership, and other problems involved, most of the irrigation water storage will have to be developed by project construction. In most cases, anadromous fish passage will have to be provided, or off-stream storage will be used.

Drainage

In the subregion, over 190,000 acres of cropland have a wetness problem. The demand for agricultural products will make the drainage of some of these soils necessary.

Main outlet ditch for tile drains. (SCS 0-1030-5)

Complete drainage of most of the wet areas is not possible without prior flood control. However, most of the wet areas can be drained to such a degree that wetness is not a serious problem during a 4 to 5-month growing season.

Drainage of wet soils as projected in future needs will continue to be accomplished both by individuals and by drainage or diking districts. Public funds will be used for cost sharing and technical assistance.

Drainage in the interior Umpqua, Rogue, and Chehalis basins is mostly from moving underground water at or near the soil surface. In these areas, the orderly movement of ground water is interrupted by soil changes, gravel, dikes, or other types of obstructions. Drainage problems are caused by soils becoming saturated during the winter rainy season and retaining the water during the growing season. Expanded irrigation is expected to multiply the drainage problems in these basins.

There are almost 26,000 acres of cropland in the Rogue Basin needing drainage. About half of this is in the Bear Creek Valley near Medford, Oregon. Because of topography and stratigraphy, this area should be drained as a unit. Most of the remaining areas can be drained by individual landowners with some community outlets installed by small groups. Drainage problems in Bear Creek Valley are expected to compound with the addition of irrigation water. Any project to provide irrigation water should also consider the

effect this will have on drainage. Table 448 shows the drainage practices that will be necessary to drain cropland areas at the projected rate.

Table 448 - Cumulative Practices Required to Provide Needed Drainage, Subregion 10

Practice	Unit	1966	1980	2000	2020
Drainage Conduits & Ditches	Miles	1,506	3,500	6,160	8,800
Drainage Structures	No.	401	930	640	2,340

Source: Soil Conservation Service, C-NPRBS Data.

Erosion and Sedimentation

Of the 32,000 acres of cropland with an erosion problem, 22,000 acres are in the Rogue Basin. About 2,000 acres can be attributed to flood plain cutting, about 3,300 acres to poor irrigation practices, and the remaining 16,700 acres to the surface runoff of precipitation. Coastal areas and the interior valleys of the Umpqua and Chehalis basins have only minor erosion problems in cropland areas. This can be attributed to the crops grown. Shifts in cropland areas from better soils to more erodible soils are expected to increase the erosion potential by about 9,000 acres.

Most of these problems will be solved by individual landowners with cost sharing and technical assistance from public funds. Table 449 shows the practices that are necessary to treat those areas with an erosion problem as well as maintain other areas in a stable condition.

Table 449 - Required Erosion Control Practices Subregion 10

Practice	Unit	1966	1980	2000	2020
Grade Stab. Structures	No.	33	56	87	117
Diversions and Terraces	Miles	28	48	74	100
Ditch Bank Seeding	Miles	7	12	18	25
Crop Residue Use	1000 Acs.	39.6	67.3	104.2	140.4
Grassed Waterway	1000 Acs.	0.7	1.2	1.8	2.5
Cons. Cropping System	1000 Acs.	119.8	203.7	315.2	424.8
Pasture & Hay Land Planting	1000 Acs.	94.9	161.3	249.7	336.5

Source: Soil Conservation Service, C-NPRBS Data.

Flooding

Over 223,000 acres of cropland are subject to frequent flooding. Over 75 percent is in the coastal areas of Oregon and Washington. As noted in future needs, it is not economically feasible to completely control flooding on the tidal plains in the coastal areas.

Above the tidal plain, some flooding occurs along streams and rivers. Most of this can be corrected by diking and channel enlargement or improvement. Flood prevention by detention is not expected to be used since most coastal streams are spawning beds for anadromous fish. Public funds will be used for cost sharing and technical assistance. The limited detention of flood flows will be mostly from public funds.

A number of studies have been made on the flooding problem in the Rogue, Umpqua, and Chehalis basins, and a few projects have been proposed. Flood protection can be expected to proceed at the rate which local landowners become interested. Most of the work will be done through projects with public participation.

The heavy cost of protecting stream and river banks from erosion usually cannot be economically justified solely from the standpoint of land protected. Considerations such as debris, silt, pollution, and others must be included to make bank protection feasible. For this reason, most of the erosion control is expected to be included in project planning with participation by public funds.

Table 450 shows the flood control work that individual landowners are expected to accomplish.

Table 450 - Cumulative Cropland Flood Prevention Practices, Subregion 10

Practice	Unit	1966	1980	2000	2020
Stream Channel Imp.	Miles	311	1,265	2,540	3,820
Streambank Protection	Miles	122	496	995	1,490
Stream Channel Stab.	Miles	4	16	33	50
Dikes and Levees	Miles	114	464	930	1,400

Source: Soil Conservation Service, C-NPRBS Data.

Program Costs

The estimated cost of providing for the conservation and improvement of the subregion's cropland resources is shown in table 451. These costs are in terms of 1969 dollars.

Table 451 - Estimated Cost of Cropland Conservation Practices, Subregion 10

Item	Water Conservation	Drainage	Erosion Control	Flood Control	Total
			(1,000 dollars)		
1966-1980					
Private Funds	105,030	6,926	1,065	923	113,944
Public Funds	26,255	2,969	188	1,961	31,373
Technical Cost1/	2,869	1,858	822	169	5,718
Total	134,154	11,753	2,075	3,053	151,035
1981-2000					
Private Funds	221,495	19,092	2,440	2,902	245,929
Public Funds	48,622	8,182	431	6,168	63,403
Technical Cost	6,556	5,124	1,883	583	14,146
Total	276,673	32,398	4,754	9,653	323,478
2001-2020					
Private Funds	316,020	29,574	3,481	4,720	353,795
Public Funds	64,732	12,674	614	10,030	88,050
Technical Cost	9,864	7,936	2,685	973	21,458
Total	390,616	50,184	6,780	15,723	463,303

1/ Includes public and private costs.
Source: Soil Conservation Service, C-NPRBS Data.

Forest Land

Land management practices need to be intensified with the removal of old-growth timber stands. The impacts of timber harvesting along with increasing activity generated by other forest users, will cause mounting pressures on the forest land. Accelerated levels of watershed management will be required to reduce sediment levels and to benefit streamflows through vegetation and snowfield management. These practices must be a part of any plan for development or utilization of the forest resources, particularly with the construction of the structures and other projects designed to develop the water potential of the subregion.

Watershed Protection

It is anticipated that the intensity of watershed protection conducted concurrently with logging and road construction, as shown in table 431, will probably accelerate or at least continue at present levels on the public forest lands. A level at least equal to the present public land rate will be necessary for the private areas by 2020, especially in locations with a high erosion or sediment yield potential. Table 452 outlines the anticipated total cost of such measures, accumulated through the year 2020. These costs are based on the assumption that: (1) On the public forest lands, controls through timber sale and construction contracts are adequate if properly applied, and (2) on the private forest lands, the minimum required in year 2020 will be about equal to that presently done on the public lands.

Table 452 - Projected Costs for Watershed Protection Practices, Forest Land, Subregion 10

Practices	Unit	Total Units1/	Total Cost1/
	PUBLIC FOREST LAND		
Logging Disturbance Treatment	Ac.	172,000	5,160
Harvest Road Treatment2/	Mi.	24,100	6,025
Other Watershed Requirements3/	Ac.	7,127,000	221,460
Total Cost			232,645
	PRIVATE FOREST LAND		
Logging Disturbance Treatment	Ac.	150,000	3,750
Harvest Road Treatment	Mi.	21,000	4,200
Other Watershed Requirements	Ac.	6,576,000	130,000
Total Cost			137,950
	TOTAL ALL LAND		
Logging Disturbance Treatment	Ac.	322,000	8,910
Harvest Road Treatment	Mi.	45,100	10,225
Other Watershed Requirements	Ac.	13,703,000	351,460
Total Cost			370,595

1/ Total for 55-year period 1965-2020. Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, timber cultural practices, special road requirements, and other indirectly related items.

At this rate, recurrent watershed protection measures will cost about $4,230,000 annually on the public forest lands and should cost about $2,510,000 annually on the private. Converting the annual costs to totals, this amounts to $370,595,000. This represents the cost of maintaining the productive condition of the forest watersheds under the pressures of the projected demands.

Watershed Rehabilitation

The areas in the medium yield category on table 430 produce most of the sediment attributable to land use activities. This amounts to 400 acre-feet of sediment per year or nearly 20 percent of the total from all forest lands in the subregion.

The acreage presently requiring treatment and the amount that should be accomplished during time periods 1980, 2000, and 2020, are listed in table 453. Typical of these program needs is the stream clearance work pictured on the following page. Massive log jams, both natural and man-caused, block many miles of coastal streams. This debris is either piled and burned on the streambank, or scattered in the standing timber above the high water mark. Table 454 outlines the expected sediment reduction through the application of these measures.

Table 453 - Projected Watershed Rehabilitation Programs, Forest Land, Subregion 10

Item	Unit	1980 Amount	1980 Cost1/ ($1,000)	2000 Amount	2000 Cost1/ ($1,000)	2020 Amount	2020 Cost1/ ($1,000)
FEDERAL LANDS							
Land Treatment	Ac.	10,600	972	11,100	1,362	1,100	212
Stream Rehabilitation	Mi.	1,075	9,932	750	9,536	162	1,653
Road Rehabilitation	Mi.	2,480	268	1,045	180	1,428	49
Total Cost			11,172		11,078		1,914
NONFEDERAL LANDS							
Land Treatment	Ac.	30,900	2,457	41,300	3,282	30,600	2,441
Stream Rehabilitation	Mi.	315	1,750	230	1,360	33	165
Road Rehabilitation	Mi.	725	36	590	30	212	10
Total Cost			4,243		4,672		2,616
TOTAL ALL LANDS							
Land Treatment	Ac.	41,500	3,429	52,400	4,644	31,700	2,653
Stream Rehabilitation	Mi.	1,390	11,682	980	10,896	195	1,818
Road Rehabilitation	Mi.	3,205	304	1,635	210	1,640	59
Total Cost			15,415		15,750		4,530

1/ In 1969 dollars.

A rubber-tired tractor removes debris from an anadromous fish stream in the Coastal Subregion. (Forest Service)

Table 454 - Expected Annual Sediment Reduction
Forest Land Rehabilitation, Subregion 10

Present Yields 1/	Acres (1,000)	Total Sed. Yield Ac-ft./Yr.	Acres Treated 2/	Sediment Reduction Ac-ft/Yr.
Very low	1,294.7	40	--	--
Low	11,328.8	1,770	--	--
Medium	1,205.1	377	350,000	98.5
High	--	--	--	--
Very High	--	--	--	--
Total	13,828.6	2,187		98.5
		Total reduction, percent		5

1/ Data from table 430
2/ Data from table 453. Miles treated converted to acres.

The overall expected sediment reduction is 5 percent or nearly 100 acre-feet per year. This represents a large share of the sediment resulting from the accelerated erosion caused by land use activities. This decrease will all occur on lands in the medium yield category.

In addition to the needs for sediment reduction on the presently eroding forest lands, nonrecurrent work will be required on any future extensive large forest burns and lands directly related to future water storage projects. These sediment sources will be treated as they occur, when and if treatment is needed. Hence, the 5 percent overall sediment reduction is that amount possible should no new sources occur through catastrophic fire or other natural disaster.

Water Yield Improvement

Snowpack management may be the single most significant factor in prolonging runoff. This, coupled with water spreading to maintain the water table and reduce peak flows, will provide the management tools for water yield improvement. Some cover manipulation will be accomplished incident to the other practices.

Table 455 lists the projected water yield improvement programs needed and the amount that should be accomplished during time periods 1980, 2000, and 2020. Timber cover on the private forest lands is modified principally by logging requirements. Therefore, neither water yield improvement practices nor benefits are estimated, although some benefit does occur.

Table 455 - Projected Water Yield Improvement Practices, Public Forest Land, Subregion 10

Item	Unit	1980 Amount	1980 Cost1/ ($1,000)	2000 Amount	2000 Cost1/ ($1,000)	2020 Amount	2020 Cost1/ ($1,000)
Cover Manipulation2/	Ac.	-	-	-	-	250	4
Snowpack Management	Mi.	50	2,500	75	3,750	65	3,250
Water Spreading3/	Ac.	825	332	1,300	459	100	1
			2,832		4,209		3,255

1/ In 1969 dollars.
2/ Includes type conversion and riparian vegetation management.
3/ Planned for altering timing of runoff or ground-water recharge, not for irrigation or other resource activity.

Total Program Costs

In summary, the total cost of forest watershed protection and land treatment programs through the year 2020 may be expressed as follows:

	Costs ($1,000)
Watershed Protection	370,595
Watershed Rehabilitation	35,695
Water Yield Improvement	10,296
	416,586

Rangeland

Measures and Practices for Watershed Protection

Requirements to satisfy future needs for rangeland watershed protection, rehabilitation, and improvement in Subregion 10 are shown on tables 456, 457, and 458. Most of these measures which improve watershed conditions also have other management objectives or purposes. Cover improvement and soil stabilization practices will be needed on about 232,000 acres. Some of these will be recurring efforts and a combination of practices should be applied to some areas. Around 70,500 acres require revegetation, including establishment of grasses, legumes, or browse species on 66,400 acres and shrub planting on 4,100 acres. Two-fifths of the grass seeding will be a recurring practice. More than half of these revegetation efforts will be for improved watershed conditions, and the remainder for improved forage production.

Table 456 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Subregion 10 1/

Measures & Practices	Units	Land Ownership: Public 3/	Private	Total	Watershed Purposes 2/: (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	7,100	4,100	11,200	x	x	x	x
Brush Control	Acres	2,600	1,500	4,100	-	-	x	-
Weed Control	Acres	9,100	5,200	14,300	-	-	x	-
Fertilizing	Acres	4,000	2,300	6,300	-	-	x	-
Contouring, Pitting, Furrowing	Acres	125	75	200	-	x	x	x
Irrigation	Acres	400	200	600	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	200	100	300	x	x	x	-
Reducing Excessive Grazing Use	Acres	12,900	7,500	20,400	-	-	x	-
Livestock & Game Water Facilities	Number	100	60	160	-	x	-	-
Special Fire Control	Acres	25,800	14,900	40,700	-	-	x	x
Road Stabilization								
Existing Roads	Miles	12	8	20	-	x	x	x
New Roads	Miles	12	8	20	x	-	x	x
Pollution Abatement	Miles	6	3	9	-	-	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	100	100	200	-	x	x	x
	Acre Ft.	80	50	130	-	x	x	x
Check Dams (Gully Plugs)	Number	700	400	1,100	-	x	x	x
	Cu. Yds.	70,600	40,800	111,400	-	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.

Table 457 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1981 to 2000, Subregion 10 1/

Measures & Practices	Units	Land Ownership			Watershed Purposes 2/			
		Public 3/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	19,800	11,400	31,200	x	x	x	x
Brush Control	Acres	6,500	3,700	10,200	-	-	x	-
Weed Control	Acres	15,500	8,900	24,400	-	-	x	-
Fertilizing	Acres	11,600	6,700	18,300	-	-	x	-
Contouring, Pitting, Furrowing	Acres	300	100	400	-	x	x	x
Irrigation	Acres	700	400	1,100	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	400	200	600	x	x	x	-
Reducing Excessive Grazing Use	Acres	19,400	11,200	30,600	x	x	x	x
Livestock & Game Water Facilities	Number	200	100	300	-	x	-	-
Special Fire Control	Acres	64,500	37,300	101,800	-	x	x	x
Road Stabilization								
Existing Roads	Miles	30	20	50	x	x	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	400	200	600	x	x	x	x
	Acre Ft.	300	100	400	x	x	x	x
Detentions	Number	6	3	9	-	-	x	x
	Cu. Yds.	6,500	3,700	10,200	-	-	x	x
Check Dams (Gully Plugs)	Number	2,000	1,100	3,100	-	x	x	x
	Cu. Yds.	199,600	115,500	315,100	-	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.

Table 458 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2001 to 2020, Subregion 10 1/

Measures & Practices	Units	Land Ownership			Watershed Purposes 2/			
		Public 3/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	17,800	10,300	28,100	x	x	x	x
Brush Control	Acres	14,200	8,200	22,400	-	-	x	-
Weed Control	Acres	15,500	8,900	24,400	-	-	x	-
Fertilizing	Acres	19,400	11,200	30,600	-	-	x	-
Contouring, Pitting, Furrowing	Acres	300	100	400	-	x	x	x
Irrigation	Acres	1,000	500	1,500	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	400	200	600	x	x	x	-
Reducing Excessive Grazing Use	Acres	19,400	11,200	30,600	x	x	x	x
Livestock & Game Water Facilities	Number	400	200	600	-	x	-	-
Special Fire Control	Acres	64,500	37,300	101,800	-	x	x	x
Road Stabilization								
Existing Roads	Miles	100	100	200	x	x	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	500	300	800	x	x	x	x
	Acre Ft.	200	100	300	x	x	x	x
Detentions	Number	20	10	30	-	-	x	x
	Cu. Yds.	19,400	11,200	30,600	-	-	x	x
Check Dams (Gully Plugs)	Number	3,200	1,900	5,100	-	-	x	x
	Cu. Yds.	328,600	190,200	518,800	-	-	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion and Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County and Municipal Ownership.

Other significant improvement and stabilization measures include brush control on 36,700 acres, control of weeds on 63,100 acres, and contouring of about 1,000 acres.

Between 1966 and 2020, excessive grazing use should be reduced on about 81,600 acres, and recurring adjustment will be

necessary on about 130,000 acres as increased efforts are directed to grazing systems integrated with use of farm pasture land, to increase range grazing capacity along with adequate cover improvement and soil stabilization for watershed protection. Wildlife use of rangelands must be studied and maintained in balance with livestock use. About 1,000 miles of control fence should be constructed for protection of conservation works, rehabilitation of eroded lands, and restriction of livestock use in areas that have wildlife value and nearly 500 miles of fence must be replaced. Some 1,060 livestock and game water facilities should be developed (including 300 replacement or maintenance needs) for better livestock distribution, conservation of water supplies, and preservation of water quality. On about 270 miles of existing access roads and trails, and 20 miles of new roads, special protection measures are necessary to reduce erosion and excessive runoff.

Between 1966 and 2020, about 700 ponds and small reservoirs should be constructed and 900 existing structures will require replacement. During this period an estimated 5,100 check dams need to be constructed in numerous rangeland drainages for watershed improvement and some 4,200 existing dams must be repaired or replaced.

Erosion occurring on a dam of a small stock water pond is due to lack of maintenance and on improperly constructed spillway. A number of water facilities are needed in this subregion and many will require reconstruction or maintenance work. (SCS 0-2196-15)

Erosion and Sediment Yield Improvement

Reduction or redistribution of grazing use on some areas and improved vegetative cover should result in a 59 percent reduction of the annual sediment yield, from 37 acre-feet in 1966 to 15 acre-feet in 2020 (table 459).

Table 459 - Sediment Yield Projections for Rangeland, Subregion 10

Sediment Yield 1/ Categories	1966	1980	2000	2020
		Rangeland Acreage (1,000 Acres)		
Very Low	46.7	76.7	135.4	212.3
Low	108.4	85.9	57.4	18.4
Medium	13.5	10.2	5.9	--
High	--	--	--	--
Very High	--	--	--	--
Total	168.6	172.8	198.7	230.7
Percent Change from 1966	.0	+2.5	+17.9	+36.8
		Annual Sediment Yield (Acre-Feet)		
Very Low	5	7	13	20
Low	25	20	13	4
Medium	7	6	3	--
High	--	--	--	--
Very High	--	--	--	--
Total	37	33	29	24
Percent Change from 1966	.0	-11.3	-20.8	-34.8

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.

Improved Range Condition and Capacity

Estimated future potential range improvement, shown on table 460, will result partly from required practices for watershed rehabilitation and protection, shown in tables 456, 457, and 458, and partly from other management practices. Good condition range will be increased from 24 percent of the range in 1966 to 72 percent in 2020, or from 41,300 acres to 100,700 acres. Poor condition range, which accounted for 53 percent of the total land in 1966,

Table 460 - Estimated Potential Rangeland Improvement, Subregion 10

Range Type and Condition	Acres (1,000)	AUMs (1,000)	Acres (1,000)	AUMs (1,000)	Acres (1,000)	AUMs (1,000)	Acres (1,000)	AUMs (1,000)
Grassland								
Good	1.2	.5	4.6	1.8	11.2	4.5	18.6	7.5
Fair	18.0	3.0	18.4	3.1	17.6	2.9	12.4	2.0
Poor	49.9	2.9	38.8	2.3	14.8	.9	8.3	.5
Seeded Range	32.2	10.7	38.3	12.7	59.1	19.7	58.2	19.4
Total	101.3	17.1	100.1	19.9	102.7	28.0	97.5	29.4
Sagebrush								
Good	-	-	-	-	-	-	-	-
Fair	-	-	-	-	-	-	-	-
Poor	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-
Other Brush								
Good	7.9	2.0	11.2	2.8	17.5	4.4	23.9	6.0
Fair	19.6	2.3	18.7	2.2	16.1	1.9	11.3	1.3
Poor	39.8	1.5	30.0	1.1	13.7	.5	7.3	.3
Total	67.3	5.8	59.9	6.1	47.3	6.8	42.5	7.6
Total								
Good1/	41.3	13.2	54.1	17.3	87.8	28.6	100.7	32.9
Fair	37.6	5.3	37.1	5.3	33.7	4.8	23.7	3.3
Poor	89.7	4.4	68.8	3.4	28.5	1.4	15.6	.8
Grand Total	168.6	22.9	160.0	26.0	150.0	34.8	140.0	37.0
Average AC/AUM	7.4		6.1		4.3		3.8	
Percent Change from 1966	.0	.0	-5.1	+13.7	-11.0	+51.7	-17.0	+61.5

1/ Includes seeded range.
Source: Table 501 - "Present Status" rangeland narrative. Future estimates for this study are based on representative on-site surveys for production guides with consideration to the capability of the range for improvement with proper management and utilization.

will be decreased to 11 percent by 2020, from 89,700 acres to 15,600 acres. Although total rangeland acreage is expected to drop about 29,000 acres, improved conditions will result in a 62 percent increase in range grazing capacity from 22,900 AUMs in 1966 to 37,000 AUMs in 2020.

Estimated Program Costs

The total estimated investment cost for rangeland watershed protection and improvement is $3.4 million between 1966 and 2020 (1969 dollars) as shown on table 461. Cover improvement and soil stabilization programs will require $1.3 million, or 38 percent of the total; watershed oriented land management practices require $812,000 or 24 percent; and water control structures require $1.3 million or 38 percent of all costs.

Table 461 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Subregion 10 1/

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
		Public Land		
Cover Improvement and Soil Stabilization	161.0	330.4	345.1	836.5
Watershed Oriented Land Management Practices	71.6	141.6	267.5	480.7
Water Control Structures	90.8	268.8	456.6	816.2
Total	323.4	740.8	1,069.2	2,133.4
		Private Land		
Cover Improvement and Soil Stabilization	81.9	195.0	199.6	476.5
Watershed Oriented Land Management Practices	40.7	79.6	210.6	330.9
Water Control Structures	75.9	141.9	271.2	489.0
Total	198.5	416.5	681.4	1,296.4
		Total		
Cover Improvement and Soil Stabilization	242.9	525.4	544.7	1,313.0
Watershed Oriented Land Management Practices	112.3	221.2	478.1	811.6
Water Control Structures	166.7	410.7	727.8	1,305.2
Total	521.9	1,157.3	1,750.6	3,429.8

1/ Based on measures and practices shown on tables 456, 457, and 458 with constant 1969 dollars.

Other Land

Other land areas will increase by over 290,000 acres by 2020. The increase will be for home and industrial sites, roads, recreation areas, and water, with barren lands remaining about the same. Most of the shift to other lands will be from cropland.

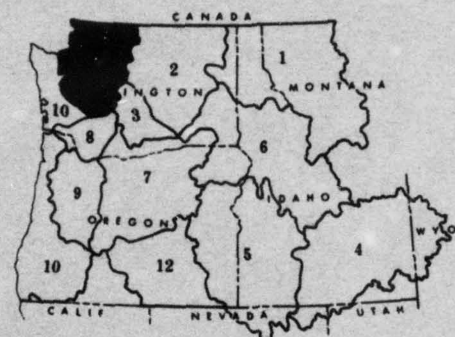
The subregion has the most widely used recreation areas in the region. Beaches, estuaries, rivers, and dune areas receive a great number of visitors each year. This use is limited to present areas, and the only possible expansion will have to be through increased use per square mile. Since the demand for this type of recreational use will continue to grow without the addition of land, these special areas will have to be protected for future use.

Considerable beach erosion is occurring in some areas. While correction of this problem is important in meeting future recreational needs, present limited development precludes much control work. As the population of the region continues to grow and more time for ocean-oriented recreation is available, additional erosion control work will have to be undertaken.

Complete dune stabilization as conifers are established on the dunes previously planted to beach grass. (Forest Service)

There is a constant and continuing need for dune stabilization along the coast. Of the 7,500 acres needing practices such as vegetation and drift fences, 2,000 acres are in critical condition and should be treated by 1980. Treatment of the remaining 5,500 acres should be distributed over the two final time periods. Cost of this work is as follows: 1966-1980, $1 million; 1980-2000, $1.5 million; and 2000-2020, $1,250,000.

There are a number of small watersheds draining directly into the estuaries and tidal waters. Some of the problems faced by local people in upper watershed areas are also factors affecting the pollution of the coastal waters. Large areas of land have soils with a wind or water erosion hazard. If these lands are left bare through timber harvesting and agricultural practices, they are a threat to water quality. Erosion on cultivated land, logged forest land, and overgrazed pasture and rangeland is the source of much sediment. Sediment greatly reduces the attraction of streams and estuaries for recreation, as well as destroying the fishery resource. The improvement of upstream watersheds through land treatment will help solve the downstream problems on these "other" lands.



LOCATION MAP

SUBREGION

11

SUBREGION 11
PUGET SOUND

PRESENT STATUS

Subregion 11 is bounded on the north by Canada, on the east by the Cascade Range, on the south by the Cowlitz River drainage and on the west by the Olympic Mountains. The area is five percent of the Columbia-North Pacific Region and contains 8,547,200 acres. This includes a land area of 8,446,600 acres and large water areas of 100,600 acres. Fifty-two percent is public land, 48 percent is privately owned. It is the most densely populated of all the subregions.

This subregion is characterized by a maritime type climate, strongly influenced by weather originating over the Pacific Ocean. Annual precipitation ranges from 35 to 50 inches over most of the lowlands, increasing to 75 inches in the foothills and from 100 to more than 200 inches on the wettest slopes of the Cascades and Olympic Mountains. About 75 percent occurs from October through March. The driest section, often referred to as the rain shadow of the Olympic Mountains, receives 16 to 30 inches of precipitation. This dry belt extends eastward from Port Angeles almost to Everett, and northward into the San Juan Islands. Nearly all of the agricultural areas have a frost-free season of 145 to 220 days. This period ranges from mid-April in the spring to late October in the fall. The longest frost-free season is on the San Juan Islands and elsewhere near the Sound. The shortest is in the valleys separated from the Sound by ridges, and in the foothills.

Runoff originating in the subregion amounts to 37.7 million acre-feet annually. Nearly all (94 percent) is from forest land areas (figure 66).

Total sediment yield is nearly 1,600 acre-feet annually. Much is produced on active timber sale areas although the urban and construction areas also account for significant amounts (table 462 and figure 68).

EXPLANATION

100

Average annual runoff

▲1130

Gaging site with Geological Survey indentification number

Notes

(1) MEAN ANNUAL RUNOFF ISOPLETHS FOR NATURAL FLOW CONDITIONS WERE DERIVED USING OBSERVED STREAM FLOWS, CLIMATOLOGICAL DATA, DEPLETIONS, AND PHYSIOGRAPHIC FEATURES OF THE BASIN FOR THE PERIOD [illegible]

(2) STREAM GAGING STATIONS SHOWN ARE SELECTED STATIONS AND ARE NOT THE ONLY STATIONS USED IN PREPARING THE RUNOFF MAP.

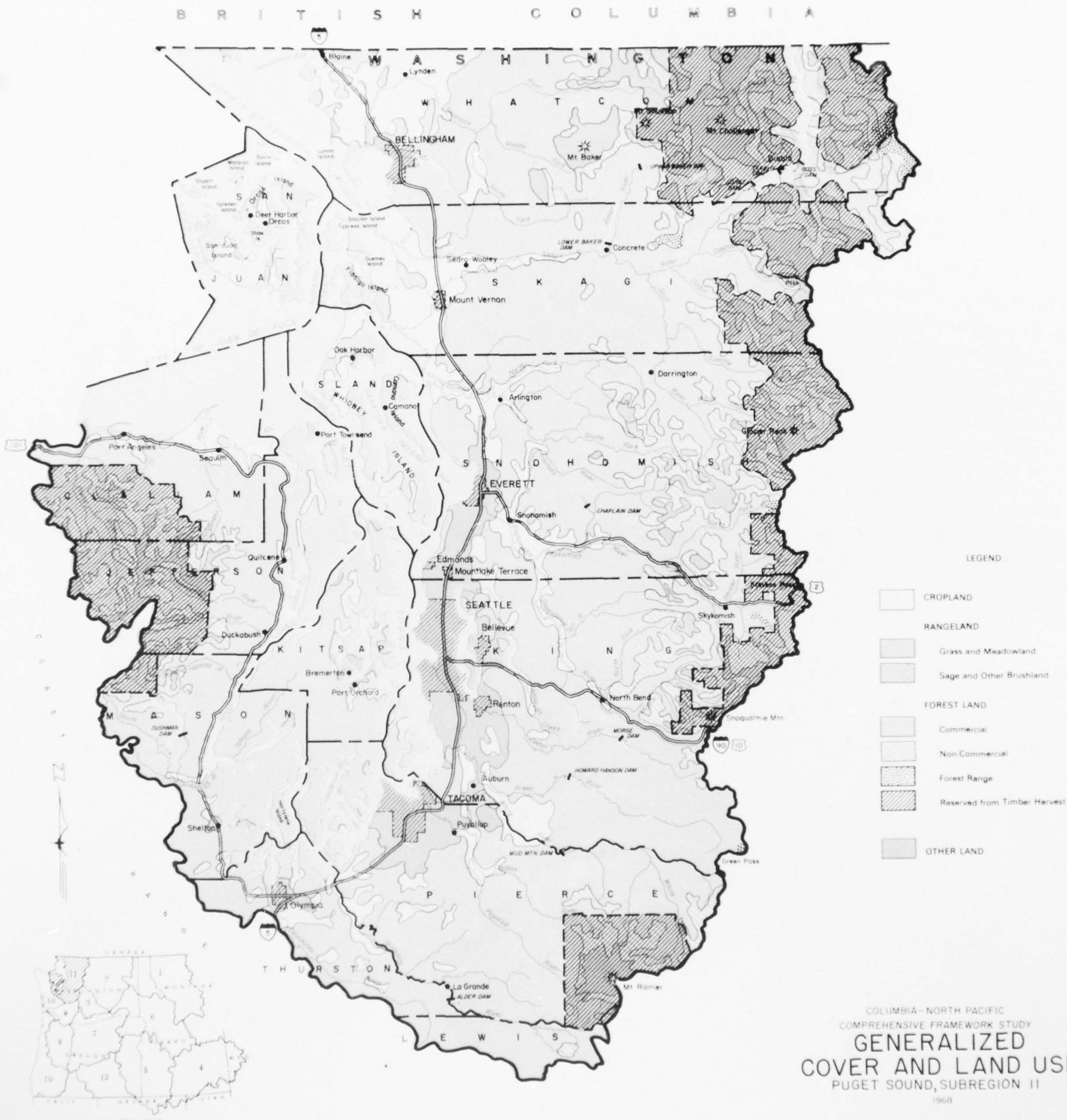
COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL RUNOFF IN INCHES

PUGET SOUND SUBREGION 11

1968

FIGURE 66



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED COVER AND LAND USE

PUGET SOUND, SUBREGION 11

1968

FIGURE 67

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

PUGET SOUND SUBREGION II

1968

FIGURE 68

Table 462 - Generalized Sediment Yield by Cover and Land Use, Subregion 11

Cover and Land Use	1,000 Acres 1/	Percent	Sediment Yield Ac-Ft./Yr	Percent
Cropland	591	7	149	9
Forest Land	6,429	76	1,013	63
Rangeland	105	1	25	2
Other Land	1,322	16	412	26
Total	8,447	100	1,599	100

1/ Based on Puget Sound and Adjacent Waters Type 2 Study data adjusted to C-NP definitions.
Source: Derived from figures 66 and 68 and Appendix IV.

Cropland

The subregion has approximately 18,576 farms with a total of 591,000 acres of cropland, an average of 32 acres of cropland per farm. Acreages of crops are shown on table 463.

Table 463 - Types of Crops, Subregion 11, 1966

Item	Hay & Pasture	Small Grain	Berries	Vegetables & Field Crops	Idle	Total
	------	------	------1000	Acres------	------	------
Dry Cropland	392.5	12.7	9.7	52.6	32.0	499.5
Irrigated Cropland	80.0	0.5	3.7	7.3	--	91.5
Total Cropland	472.5	13.2	13.4	59.9	32.0	591.0

Source: Soil Conservation Service C-NPRBS Data

Water Conservation

Approximately 16 percent of the cropland, 91,500 acres, is irrigated. All except 1,000 acres are irrigated by sprinkling. The adaptability of sprinkler irrigation systems to the various physical situations and human needs of the area will result in a continuing increase of sprinkler irrigation.

Puget Sound is essentially a glaciated, alluvial plain extending southward from the Straits of Juan de Fuca. Throughout the Puget Sound lowland, numerous river valleys, descending from

the Cascades, support many dairy, vegetable and berry farms. The value of poultry and poultry products sold in 1964 accounted for 21 percent of all farm income, the value of dairy products sold was 37 percent, and the value of livestock and livestock products was 14 percent.

The eastern part of Puget Sound is the major agricultural area. It accounts for about 72 percent of the agricultural sales. The subregion produces approximately 112 million dollars of agricultural products. The major products of the east side of the Sound are dairy, beef, poultry, strawberries, cane berries, peas, string beans, sweet corn, beets, cabbage, cucumbers, broccoli, and seed potatoes.

The southern border of Puget Sound produces about 21 percent of the agricultural sales. This area is first in the state in the production of snap beans, cauliflower, lettuce, cabbage, rhubarb, celery, and cucumbers. It produces numerous other vegetables. Washington is the leading American flower bulb producing state; virtually all are grown on the flood plains of the Lower White and Puyallup Rivers. Some of the most important bulb crops are Iris, Narcissus, Tulip bulbs, and Gladiolus corms.

The western part, including San Juan Island, and Kitsap Counties, produces about seven percent of the agricultural income. Dairy farming is the most important; beef cattle, sheep and lambs are prevalent on many farms. The San Juan Islands are one of the state's leading sheep producing counties. The Dungeness-Sequim lowlands are used predominately for the production of alfalfa or timothy clover for livestock feed. The Kitsap Peninsula and the area south of Hood Canal are berry and fruit areas. Vashon Island leads the state in the production of currants.

Table 464 shows a number of water conservation practices applied on cropland by individuals and groups that have been effective to overcome some of the problems.

This subregion has a summer period of water shortage for farming and a winter period of water surplus. Irrigation development has generally been accomplished on an individual farm basis, pumping from streams or groundwater. Clallam County is an exception, four irrigation districts deliver project water to 13,000 acres in the northeastern part of the county.

Table 464 - Water Conservation Practices Applied on Cropland, Subregion 11, 1966

Practice	Units	Total
Water Control Facilities	No.	286
Irrigation Water Conveyance Facilities	Miles	18
Water Storage Facilities	No.	1,181
Irrigation System, Sprinkler	No.	2,213
Land Shaping	Acres	7,698
Irrigation Water Management	Acres	19,014

Source: Soil Conservation Service, C-NPRBS Data.

The source of water for irrigation is 61 percent from surface flow and 39 percent from groundwater (table 465).

About 80 percent of the hay and pasture and nearly 20 percent of the row crops are irrigated.

Table 465 - Water Availability and Irrigation Methods for Cropland, Subregion 11, 1966

Item	1,000 Acres	Percent
Water Source		
Streamflow	55.2	60
Groundwater	34.7	38
Reservoir Storage	1.6	2
Total	91.5	100
Area with Adequate Supply	91.5	100
Area with Inadequate Supply	--	--
Method of Application		
Sprinkler	90.4	99
Flooding	1.1	1

Source: Soil Conservation Service, C-NPRBS Data.

Drainage

Approximately 518,000 acres of cropland have a wetness problem, mostly associated with overflow, seepage, heavy winter

precipitation and inadequate outlets (table 466).

Table 466 - Cropland Areas with a Wetness Problem, Subregion 11, 1966

Capability Class	Area 1,000 Acres
II	261
III	187
IV	70
Total	518

Source: Soil Conservation Service, C-NPRBS Data

There are many seeps from higher lands, as well as perched water tables that extend the winter wet season into the growing season.

Surveying for the installation of a tile drain to remove excess surface water and to drain the soil profile. (SCS W-1145-7)

Considerable work has been done to relieve drainage problems as shown on table 467. It is estimated that 236,000 acres of cropland are inadequately drained for present cropping use.

Table 467 - Drainage Practices Applied to Cropland
Subregion 11, 1966

Practices	Units	Total
Conduits and Ditches	1,000 feet	2,445
Structures	No.	274

Source: USDA, Soil Conservation Service Data

Areas subject to overflow or ponding during normal winter precipitation can usually be corrected on an individual farm basis by interceptors. Many outlet facilities have required the cooperation of two or more landowners. Drainage of cropland will usually make possible an increase in the number of crops that can be grown, as well as to lengthen the growing season.

Erosion and Sedimentation

Table 468 shows the soils areas in the cropland capability classes with a severe erosion potential. Presently there are over 294,000 acres of cropland with an erosion potential.

Table 468 - Cropland Areas with an Erosion Potential by Capability Class, Subregion 11, 1966

Capability Class	Total 1,000 Acres
III	43
IV	251
Total	294

Source: Soil Conservation Service, C-NPRBS Data

Land damage from erosion, leaching, scour, and deposition is significant. Table 469 shows the present status of erosion control. Much of the work on erosion control has been done by individuals or small groups.

Cropland not adequately protected during excessive runoff is destroyed by erosion. (SCS W-1445-2)

Table 469 - Erosion Control Practices Applied on Cropland
Subregion 11, 1966

Practice	Units	Total
Grade Stabilization Structures	No.	9
Ditch Bank Seeding	Miles	32
Field Windbreak	Miles	1
Crop Residue Use	1,000 Acs.	32
Grassed Waterway	1,000 Acs.	1
Conservation Cropping System	1,000 Acs.	211
Pasture and Hayland Planting	1,000 Acs.	5

Source: USDA, Soil Conservation Service Data

Most of the arable land is effectively protected from rill and sheet erosion by perennial sod-forming crops; however, when the land is plowed, care should be taken to insure protection of the soil during the months of high precipition and overflow. This can be done by careful selection of the time of tilling the fields and by planting winter cover crops.

Each year there are approximately 60,000 acres of land that are cropped and the vegetation removed. Of this acreage, about 72 percent is seeded to a close growing crop for winter protection. Much of the remaining 28 percent is on flood plains

and water may cover it part of the winter, although erosion is usually not severe unless flooding is high enough for a stream current to develop above the field.

Flooding

Considerable land is lost through streambank erosion. Damage is usually most prevalent along the swifter portions of the streams, but the problem also exists along the larger, slower portions. Bank protection is provided by structural and vegetative means plus the removal of gravel bars, drift, and brush from channels. Dredging in the lower part of the larger streams is required to maintain adequate capacity for navigation. Stream channel work is usually most beneficial when a complete unit of channel is improved in a single coordinated project rather than by piecemeal work by individual landowners.

Flooding causes erosion and sedimentation damage to cropland. Cropland damages, consisting primarily of crop and property losses, account for much of the total evaluated flood damage. November and December floods damage crops by washing out seedlings and roots and by burying plants with sediment. Because of serious drainage problems and frequent flooding, many small areas of land have not been developed for cropland. Total average annual flood damages are estimated in Appendix VII, Flood Control, to be over $16 million.

Some flood water damage reduction work has been accomplished on cropland as shown in table 470. Most of the work has been done by diking, drainage, and flood control districts.

Table 470 - Flood Prevention Measures Applied in Cropland Areas
Subregion 11, 1966

Practice	Units	Amounts
Stream Channel Improvements	Miles	87
Dikes and Levees	Miles	273
Streambank Protection	Miles	41
Stream Channel Stabilization	Miles	5

Source: USDA, Soil Conservation Service Data

Flood gates prevent water from backing into lowland areas especially during high tide. (SCS W-1937-6)

Forest Land

Forest land covers 6.4 million acres or 76 percent of the total land area in the subregion. Almost 45 percent is in private ownership, while 55 percent is public. Of this forested area, 78 percent is classed as commercial forest land and 22 percent is noncommercial.

The commercial area presently supports almost 135 billion board feet of merchantable timber, 64 percent on public land and 36 percent on private. This area supplies the raw material for a forest products industry that accounts for 20 percent of the subregion's manufacturing employment. In 1964, 2.8 billion board feet were harvested in the subregion. Grazing use of the forest areas is limited, mostly to the high alpine areas on public land, and scattered brush fields in private woodlands.

The subregion is heavily forested, and most (over 94 percent) of the surface runoff originates here. Ninety percent of the urban population, the largest in the region, depends on these forested watersheds for much of their municipal and industrial water. Irrigation water supplies, presently less than 200,000 acre-feet annually, are produced on this same area.

The forest lands of the subregion are in a good condition, providing good quality water with moderate sediment loads. Nearly all the surface runoff originates in the forest area, but only 63 percent of the total subregional sediment is produced there. Cause

Table 471 - Present Sediment Yield, Forest Land, Subregion 11

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield Acre-feet Per Square Mile	Annual Sediment Yield Total Acre-feet	Percent
Very low	--	--	0.02 - 0.1	--	--
Low	6,373.2	99	0.1 - 0.2	996	98
Medium	55.8	1	0.2 - 0.5	17	2
High	--	--	0.5 - 1.5	--	--
Very high	--	--	1.5 - 4.0	--	--
Total	6,429.0	100		1,013	100

Source: Derived from figures 67 and 68

of this sediment is a combination of glacial activity in the barren and alpine areas, heavy winter runoff with resultant streambank erosion, and a heavy timber harvest program. The average sediment yield is slightly over 1,000 acre-feet per year (table 471).

About 99 percent of the forest land is in the low sediment yield category. Sediment from these areas is the result of natural erosion caused by normal water action on the earth's crust coupled with additional amounts from land use activities. Higher yields from the remaining one percent are the result of heavy glacial activity in the alpine areas. Most of the watershed rehabilition work is presently accomplished on key areas within the low category.

Watershed Protection

As in other west side subregions, timber is harvested in clearcut blocks, units, or settings. The cable system is the principal method used. Logs on small cutting areas are removed with mobile yarders, operating from fixed locations on a road. Some timber salvage areas and thinnings, particularly on the more gentle terrain, are logged by crawler tractors. In all cases, rather extensive road systems are required.

In an attempt to reduce this road network, other methods of cable equipment are being tried. One such system, similar to the Wyssen system described in Subregion 2, uses extensive cables and winch equipped carriages. Developed by a machinery company located in the subregion, it modifies the Wyssen carriage by equipping it with a powered winch. The main cable supports the carriage, the winch pulls the felled timber up to it, and a donkey engine lowers the suspended carriage and logs to the loading area below. The carriage and a "turn" of logs are pictured on the following page.

Logs being delivered downhill to the landing by a "sky car." This system also keeps timber free of the ground, holding ground disturbance to a minimum. (Forest Service)

Tractor trails and firelines around harvest areas are usually cross-drained to reduce gully formation. Some of the steeper areas are also seeded to grass. This stabilizes the soil, reduces sheet erosion, and furnishes additional browse for wildlife.

Most temporary roads are also cross-drained to prevent gullying. Cull logs and other debris are removed from streams and steep draws, preventing the formation of debris dams. Washouts caused by these logjams have caused considerable downstream damage in the past. Mainline log haul roads are gravel surfaced and have permanent culverts. In some areas, particularly at the crossing points in anadromous fish streams, excavated material is end-hauled so it will not be wasted into these waters. Exposed cutbank and fill slopes are seeded to grass where sediment from their slopes could also be deposited in the water. The results of this seeding may be seen in the following picture.

Seeding in furrows, an attempt to retain soil moisture and reduce gullying on steep fill slopes. (Forest Service)

Reforestation measures include planting, spot seeding by hand, and aerial seeding by helicopter and a fixed-wing aircraft. Previously established seedlings are protected from both burning and logging activity by on-the-ground administrative controls. A summary of harvest activities and protection requirements is found in table 472.

Watershed Rehabilitation

Sediment from forest utilization activities comes from scattered areas throughout the subregion. Added to that from natural erosion, it amounts to nearly 1,000 acre-feet per year (table 471). Peak spring and fall flows increase sediment movement by picking up previously deposited silt from eroding streambanks and road construction activities. During the summer and winter low flow periods, major streams are relatively free of sediment, except that originating from glacial activity.

AD-A036 574 PACIFIC NORTHWEST RIVER BASINS COMMISSION VANCOUVER WASH F/G 8/6
COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
MAY 71 J CALVIN, F H CLOSNER, R J COFFMAN

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4 OF 5
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4 OF 5

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LEGEND

LOW LESS THAN 300 AC. FT PER SQ. MI. PER YEAR

Table 472 - Average Annual Timber Harvest Activity, Subregion 11

	Unit	Public	Private	Total
Harvest Area	Acres	21,000	49,000	70,000
Area Reforested 1/	Acres	17,000	30,000	47,000
Slash Disposal Area	Acres	10,500	6,000	16,500
Disturbed Area Treated 2/	Acres	1,100	--	1,100
Harvest Road Required	Miles	145	345	490
Harvest Road Treated 3/	Miles	90	35	125

1/ Includes planting, seeding and site preparation. Balance adequately stocked or requires no regenerative work.
2/ Includes seeding, mulching, debris removal and cross-draining Skid roads and logging areas.
3/ Cut and fill stabilization only.

Most of the sediment caused by land use activities results from water movement down abandoned roads and across old logged-off tracts where past watershed protection measures were limited or altogether lacking. It is on these areas, particularly in public ownership, that rehabilitation work is presently being accomplished (table 473).

Table 473 - Average Annual Accomplishment, Watershed Rehabilitation Practices on Public Forest Land, Subregion 11

Practice	Unit	National Forest 1/	BLM 2/	Indian Lands 2/	State Lands
Sheet Erosion Control	Ac.	300	--	--	--
Gully Stabilization	Mi.	--	--	--	--
Stream Clearance & Stabilization	Mi.	4	--	--	--
Existing Road & Trail Rehabilitation 3/	Mi.	15	--	--	5
Reservoir Protection	Ac.	15	--	--	--

1/ Average of period 1964-6.
2/ Minor ownership.
3/ Includes abandoned roads.
Source: Data furnished by agency as listed.

The problem of floating debris on a reservoir in the subregion. The private power utility that operates this project has since cleaned up this debris, enhancing the lake's recreational value. (Forest Service)

Reservoir protection work has been rather limited in the subregion. Some snags, stumps and floating debris have been removed from projects in the subregion. The debris removal is particularly significant, as many acres of water surface are improved for boating by this practice. The above picture shows floating debris on Lake Cushman, a Tacoma City Light power project on the Skokomish River. This material limits full use of the reservoir. Both the drift and the snags have since been removed by the utility company.

Water Yield Improvement

Some increase in streamflow normally occurs through regular timber harvest programs that remove the old-growth canopy. Some also occurs through timber stand improvement programs such as thinning and release. These benefits are minor however, and are not planned to modify water yields or the timing of downstream flows. No specific water yield programs are currently underway.

Rangeland

This subregion includes a number of small range areas intermingled with cropland and forest land, totaling 105,000 acres. Most of these lands are covered with brush, weeds, and grass, and are generally not suitable for intensive agricultural use. They are about equally divided between public and private ownership. Nearly 50 percent of the rangeland was in poor condition in 1966 (table 474), with an estimated average grazing capacity of 7 acres per animal unit month. Most rangeland has an average annual sediment yield of about 0.15 acre-feet per square mile (figure 68), and yields 25 acre-feet of sediment annually (table 475).

Table 474 - Rangeland Condition and Capacity, Subregion 11, 1966

Range Type and Condition	Ownership					
	Public		Private		Total	
	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)
Grassland						
Good	.1	.0	10.0	4.2	10.1	4.2
Fair	30.8	5.2	1.9	.3	32.7	5.5
Poor	20.3	1.6	.1	.0	20.4	1.6
Seeded Range 1/	--	--	2.5	1.2	2.5	1.2
Total	51.2	6.8	14.5	5.7	65.7	12.5
Sagebrush						
Good	--	--	--	--	--	--
Fair	--	--	--	--	--	--
Poor	--	--	--	--	--	--
Total	--	--	--	--	--	--
Other Brush						
Good	--	--	5.1	1.1	5.1	1.1
Fair	.3	.0	3.8	.4	4.1	.4
Poor	3.6	.1	26.5	1.1	30.1	1.2
Total	3.9	.1	35.4	2.6	39.3	2.7
Total						
Good 2/	.1	.0	17.6	6.5	17.7	6.5
Fair	31.1	5.2	5.7	.7	36.8	5.9
Poor	23.9	1.7	26.6	1.1	50.5	2.8
Grand Total	55.1	6.9	49.9	8.3	105.0	15.2
Percent Distribution	52.5	45.3	47.5	54.7	100.0	100.0
Average AC/AUM	8.0		6.0		6.9	

1/ Seeded Range acreage was combined with good condition grassland in Appendix IV.
2/ Includes seeded range.
Source: Rangeland narrative, C-NP Appendix IV, Subregion 11. Range production has been estimated for the C-NP study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

Measures and Practices for Watershed Protection

Because of the small acreage involved and indefinite use pattern of range areas, watershed improvement depends mostly on the management and use of surrounding crop and forest land. Measures applied through 1965 which provided some watershed benefit are shown on table 476. About 50 percent of the cover improvement and soil stabilization practices were for watershed protection or improvement. Adjustment in grazing use and better control of livestock have helped to avoid use of erodible areas and to prevent destruction of protective vegetative cover.

Table 475 - Sediment Yield from Rangeland, Subregion 11, 1966

Sediment Yield 1/ Categories	Grassland	Shrubs	Total	Percent
	Rangeland Acreage (1,000 Acres)			
Very Low	--	--	--	--
Low	63.8	39.3	103.1	98.2
Medium	1.9	--	1.9	1.8
High	--	--	--	--
Very High	--	--	--	--
Total	65.7	39.3	105.0	100.0
	Annual Sediment Yield (Acre-Feet)			
Very Low	--	--	--	--
Low	15	9	24	96
Medium	1	--	1	4
High	--	--	--	--
Very High	--	--	--	--
Total	16	9	25	100

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.
Source: Derived from figures 67 and 68

Table 476 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Up to 1966, Subregion 11

Measures & Practices	Units	Land Ownership: Public 2/	Land Ownership: Private	Total	Watershed Purposes 1/: (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	-	2,500	2,500	-	x	x	x
Brush Control	Acres	-	9,700	9,700	-	x	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	-	40	40	x	x	x	-
Reducing Excessive Grazing Use	Acres	27,700	-	27,700	-	-	x	-
Livestock & Game Water Facilities	Acres	-	200	200	-	x	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	-	50	50	x	x	x	x
	Acre Ft.	-	50	50	x	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County, and Municipal ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Other Land

Other Land comprises 1,321,600 acres, which is 16 percent of the subregion. Small water accounts for 40,500 acres, roads and railroads 72,900 acres; farmsteads, urban, industrial and miscellaneous 567,300 acres; and barren land 640,900 acres.

Barren land is 48 percent of the other land, and is comprised of rocks, glaciers, and similar areas of sparse vegetation. They are valuable for their yield of water and as open space with scenic and esthetic values. A variety of recreational interests use barren lands.

Drainage is a problem throughout the developed areas of the subregion. Wet basements, improperly functioning septic tank drain fields, and unstable roadbeds are noted in numerous areas. Poor surface drainage often results in a growth of aquatic vegetation and provides a breeding place for mosquitoes. On the plus side, such areas often provide habitat for various beneficial wildlife.

Farmestead flooded from river overflow causes damages to buildings, septic tank drain fields, roads, as well as many inconveniences. (SCS W-2011-9)

Erosion of other land is common during construction when the soil is exposed. Soil and debris eroded from a construction area enter the storm sewer system or may plug the entrance to the storm sewer.

Nearly 40,000 acres of urban development are subject to flooding at a frequency of once in ten years. In addition some roads and railroads are subject to frequent flooding.

Along Bellingham Bay in Whatcom County on the southeast shore of the Lummi Indian Reservation, from 10 to 50 feet of shore and bank have eroded over the last 50 years. This erosion has caused the abandonment of 1,000 feet of shoreland road. Rectification measures are not considered feasible since relocation of the road would be a cheaper solution.

Titlow Beach, about 3/4 mile south of the Narrows Bridge at Tacoma, is currently eroding about 1.5 feet per year. Studies on this problem are underway.

Steilacoom, a town further south on Puget Sound than Titlow Beach, is losing beach sand to littoral drift. Local interests are attempting a replenishment program.

While much of the 2,000 miles of coastline in Puget Sound is eroding, nearly 200 miles are being damaged at moderate to severe rates.

FUTURE NEEDS

Future land measures and watershed protection needs require more intensive action since population is increasing and technology has made more time available for recreation, increasing the demand for multiuse and special use of land. A rapid population growth is predicted for the subregion, with a projected 152 or more precent increase between 1960 and 2020. Farm population is expected to decrease substantially. Based upon projections in Appendix VI, Economic Base and Projection made for the Puget Sound and Adjacent Waters Type 2 Study.

Expected changes in the major cover and land use areas by 2020 are shown in table 477. The urban and other land use areas will increase by about 415,000 acres with a decline in all other cover and use types.

Production of more food and fiber will require better planning and technology.

Table 477 - Projected Change in Cover and Land Use, Subregion 11

	1966	1980	2000	2020
		1000 Acres		
Cropland	591	470	403	385
Forest Land	6,429	6,419	6,336	6,189
Rangeland	105	105	100	92
Other Land	1,322	1,433	1,576	1,737
Total	8,447	8,427	8,415	8,403

Source: Columbia-North Pacific, Projections based on Puget Sound and Adjacent Waters data adjusted to C-NP definitions.

A farm pond used for irrigation water storage, fishing, swimming, boating, and wildlife. (SCS W3948-10)

Cropland

At the present time, some 518,000 acres have a wetness problem, nearly 278,000 acres are subject to flooding, and about 294,000 acres are susceptible to severe erosion.

Projected trends show a decrease in cropland acreage. The demand for food exceeds the supply within the subregion. Irrigation is expected to increase to partially meet this demand. Table 478 shows the projected cropland and irrigated land.

Table 478 - Probable Trends in Dry and Irrigated Cropland, Subregion 11

	1966	1980	2000	2020
		1000 Acres		
Cropland				
Dry Farmed	499	336	223	169
Irrigated 1/	92	134	180	216
Total	591	470	403	385 2/

1/ Approximately 97 percent of the projections shown in C-NP Appendix IX, Irrigation

2/ The Puget Sound and Adjacent Waters Type 2 Study, projects cropland to 548,500 acres by 2020, based upon their economic projections and yield.

Source: Economic Work Group, C-NP projections based on Puget Sound and Adjacent Watersdata adjusted to C-NP definitions.

Water Conservation

Irrigation is expected to increase for the following reasons: (1) The climate is ideal for growing a variety of crops; (2) food processing plants, storage facilities, and transportation facilities are established in the subregion; (3) there is a potential for the further development of water resources; and (4) the demand for food will increase.

Irrigation is projected to increase from 92,000 acres at the present to 216,000 acres by 2020. This results from a need to increase efficiency to increase yields of field crops and forage. The method of applying water is expected to continue to be sprinkling. Table 479 shows the trend in the method of irrigation.

Table 479 - Projected Cumulative Trend in the Method of Irrigation on Cropland, Subregion 11

Item	1966	1980	2000	2020
		1000 Acres		
Sprinkler Systems	91	134	180	216
Surface Systems	1	-	-	-
Total	92	134	180	216

Source: Soil Conservation Service, C-NPRBS projections

Drainage

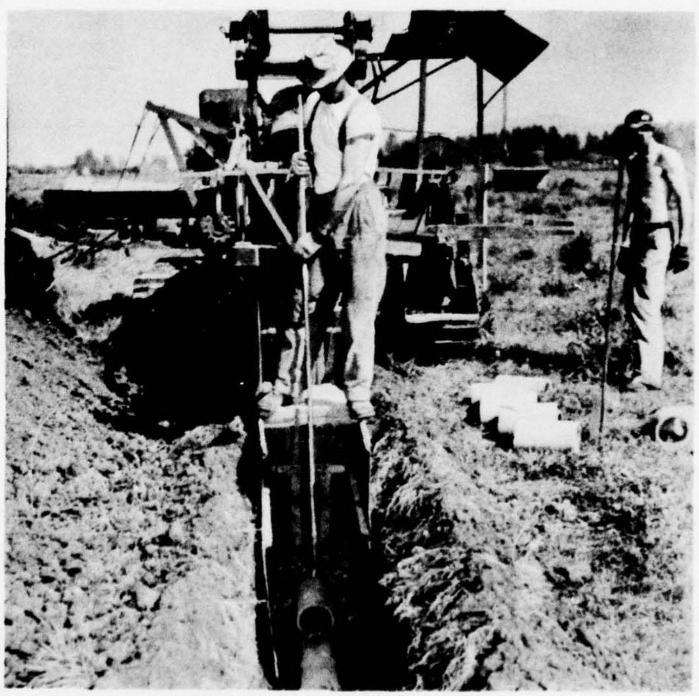
There are an estimated 518,000 acres with varying degrees of wetness. Approximately 282,000 acres have received some degree of drainage, but some 236,000 acres of crops are on soils that are still inadequately drained. A continued loss of cropland to other uses plus the development of cropland from less suitable soils may increase the need for drainage. Increased irrigation and the use of more cropland for longer season crops will require a higher degree of drainage.

Table 480 shows the trend of cropland drainage problem areas, and the projected needs for future years.

Table 480 - Cumulative Cropland Areas Needing Drainage, Subregion 11

Item	1966	1980	2000	2020
		1000 Acres		
Wet Area	518	490	448	367
Projected Accomplishments	282	315	361	347
Remaining	236	175	87	20

Source: Soil Conservation Service, C-NPRBS projections



The installation of under-ground tile removes surplus water from the soil profile and reduces wetness problems. (SCS W 1174-4)

Erosion and Sedimentation

Approximately 294,000 acres of cropland have a major erosion limitation. The primary use of this cropland is for pasture and hay, which provides cover suitable for soil protection. The use of winter cover crops is common and also effectively controls erosion. An estimated 17,800 acres are not adequately protected from erosion.

In addition to the present erosion problem area, the conversion of forest and rangeland to cropland will tend to increase the acreage of active erosion, as will the projected change from pasture and hay to clean cultivated crops, but the reduction in cropland will tend to decrease it.

Of the 591,000 acres now in cropland, about 17,100 acres have an active erosion problem. Table 481 shows the area with an erosion potential and the rate at which it is expected they will be treated.

Table 481 - Cropland Areas to be Treated for Erosion Control, Subregion 11

Item	1966	1980	2000	2020
		1000 Acres		
Erosion Potential	294	289	283	277
Projected Accomplishments	277	275	272	275
Remaining	17	14	11	2

Source: Soil Conservation Service, C-NPRBS Data

Flooding

Over 277,000 acres of cropland are subject to frequent flooding. The flooding is generally a winter occurrence. The development of new land for farming is expected to be susceptible to flooding at approximately the same percentage as present farmland.

Forest Land

The forest-based industries of the subregion will require about 931 million cubic feet of raw material per year by the year 2020. This volume of sawlogs, peelers and pulpwood will be produced principally on the 4.8 million acres of commercial forest land estimated to remain in production by the end of this time period.

This can be expressed as a need of 195 cubic-feet per acre. This is approximately 150 percent of the present industrial consumptive rate of 129 cubic-feet per acre. Both exceed the present timber growth rate of 105 cubic-feet per acre, although at present cut and growth are almost in balance. This future imbalance can be met only partially by raw material imports from other subregions since neighboring areas are also projected to increase raw material demands. This will require yield improvement programs such as improved forest management, better utilization of the present raw material, more thinning, improved restocking, fertilization, and the selection of genetically superior tree species.

The potential erosion hazard and sediment yield has been determined for the forest areas of the subregion (figure 69 and table 482). This data represents the yields that could be expected if watershed protection requirements are ignored. This could result in a four fold increase.

Table 482 - Potential Sediment Yield without Protective Measures, Forest Land, Subregion 11

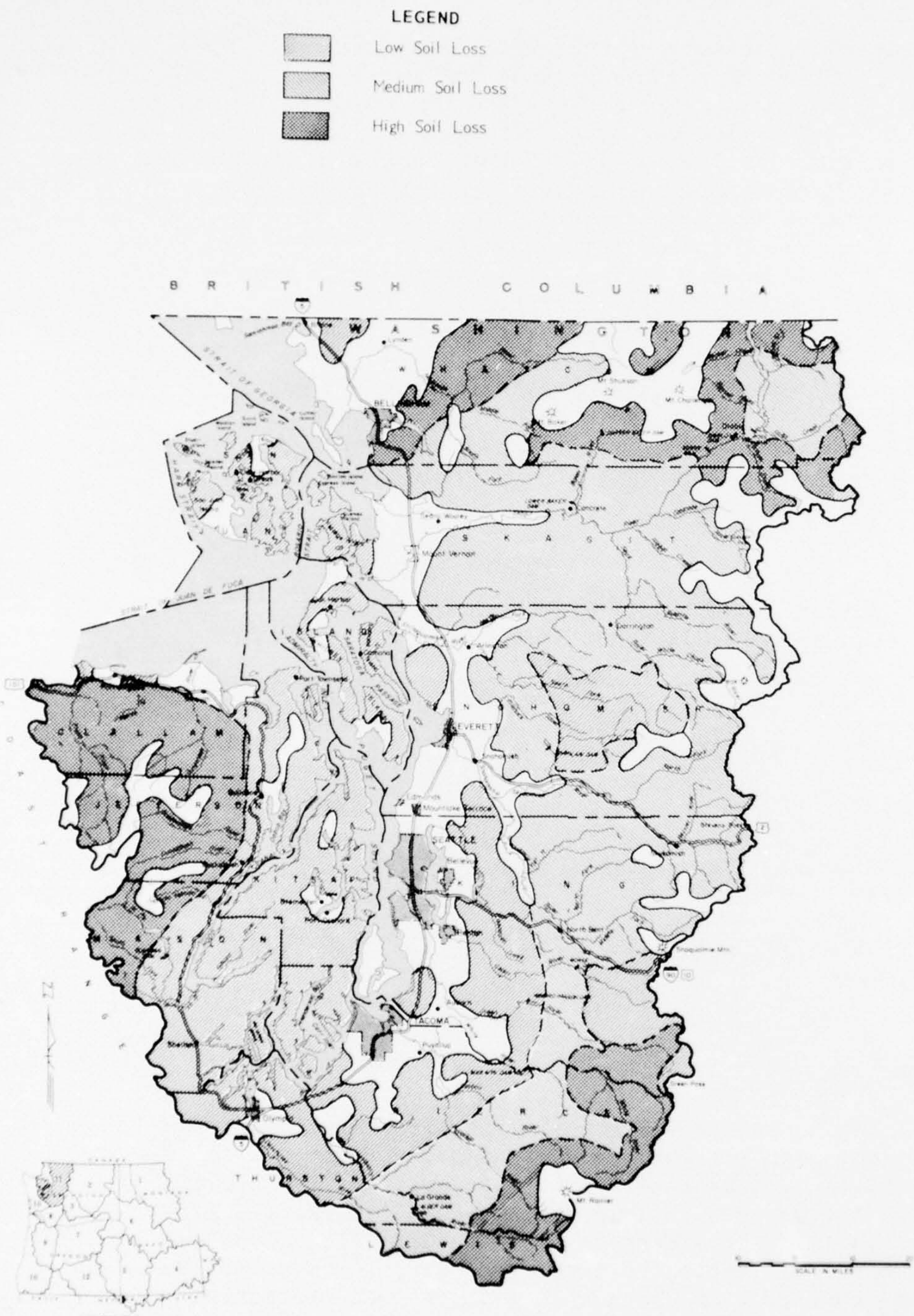
Soil Loss Category	Acres (1,000)	Percent	Acre-feet per Square Mile per year	Total Acre-feet per year
Low	2,250.3	35	Less than 0.2	352
Medium	3,085.5	48	0.2 - 1.5	964
High	1,093.2	17	More than 1.5	2,562
Total	6,429.0	100		3,878

Source: Soil Survey Data & Interpretations, U.S. Forest Service, Region 6.

Watershed Protection

To meet the increased raw material requirements in the subregion, the present annual timber harvest and road construction program, will continue or be accelerated, at least until the ultimate road system is complete. Table 483 shows the cumulative program necessary to meet these demands by the years 1980, 2000, and 2020. It also gives the estimated acreage of ground disturbed by logging and road construction which will require such protective measures as seeding, mulching and restoring a protective ground cover.

This table indicates that by the year 2020, nearly 450,000 acres of forest land will have the ground cover severely disturbed by timber harvest and road construction activities. Over 3 1/2



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

POTENTIAL EROSION HAZARD FOREST LAND

PUGET SOUND, SUBREGION 11

1968

FIGURE 69

USDA-SCS-PORTLAND, OREG. 1969

million acres will be harvested during this period. With such an impact, accelerated protective measures and increased technical assistance are urgently needed.

Table 483 - Projected Cumulative Timber Harvest Activity
Forest Land, Subregion 11 1/

	Unit	1980	2000	2020
Timber Harvest Area	Ac.	1,044,000	2,363,000	3,623,000
Road Construction	Mi.	7,300	16,500	25,400
Ground Disturbance 2/	Ac.	125,000	283,000	435,000

1/ Based on the 1965 level of timber requirements.
2/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.

Watershed Rehabilitation

Protecting the water resource will necessitate the maintenance of stable watershed areas and quick rehabilitation of the damaged ones. The critical areas requiring rehabilitation are scattered throughout the area classified as producing low sediment yields (table 471). They amount to over 50,000 acres according to present inventories. Other serious problems are the miles of eroding streambank and logjams that damage the subregion's major tributaries, blocking miles of fish spawning area and reducing recreational values.

Water Yield Improvement

In this subregion, the timing of streamflows is probably more important than increases in total water yield. Many tributaries have extremely varied flows between the fall and early spring. Most peaks are the result of heavy snowfall followed by melting rains. Runoff of this magnitude can normally be controlled only by regulatory structures. However, modified cuttings can reduce snowmelt, aiding in peak reduction. This peak reduction has the effect of increasing summer and early fall flows, probably the greaest benefit of water yield improvement.

The *Water Retention Capacity Map (figure 70)* indicates the location of the ground water storage capacities of the forest soils of the subregion. These soils have a potential storage capacity of almost 7-1/2 million acre-feet (table 484). This area can be used as a temporary reservoir, allowing infiltrated waters to appear as late season improved flows. The snowpack management

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER RETENTION CAPACITY FOREST LAND

PUGET SOUND, SUBREGION II

1968

FIGURE 70

practice of increasing accumulation, coupled with the cover manipulation practice of reducing snowmelt, will make available the additional flows needed to fill this ground-water reservoir, enhancing late summer streamflows.

Table 484 - Water Retention Capacity, Forest Soils, Subregion 11

Retention Class	Acres (1,000)	Percent	Acre-feet per Square Mile	Total Acre-feet
Low	2,828.8	44	Less than 300	1,326,000
Medium	3,407.5	53	300 - 1,500	4,792,000
High	192.7	3	More than 1,500	1,200,000
Total	6,429.0	100		7,318,000

Source: Soil Survey Data & Interpretations, U.S. Forest Service, Region 6

Rangeland

Heavy precipitation and relatively high runoff in the winter and spring cause erosion of some range areas where the cover has been depleted by livestock grazing or other land use activities. Drainage problems exist on certain low lying areas, and excessive runoff through rangeland areas causes flood damage to downstream cropland and urban areas.

Projected Use of Range Resources

The 1966 range acreage of 105,000 acres is expected to decrease to 92,000 acres by 2020 and will be subject to continual shifts in use. Some non-stocked forest brush land may be added to rangeland during this period and some cropland will revert to range. However, other range tracts will be converted back to forest use, and areas near population centers to urban or "other" land use. (3) Range watershed condition will continue to depend on management and use of adjoining cropland and forest land. Some areas will be improved in conjunction with adjacent agricultural enterprises, while others may decline through a period of inattention or future land use speculation.

Watershed Needs

Land treatment practices have been applied on an estimated

12,200 acres for erosion and sedimentation control with accompanying benefits for flood control and drainage. These practices have also helped improve water retention quality of the soils. An additional 4,700 acres will require treatment by 1980, 9,900 acres by 2000, and 15,300 acres by 2020. Protection and management practices have covered some 27,700 acres including reduction or adjustment of livestock grazing use to that compatible with the grazing capacity of the land, development of livestock and game water facilities, and construction of livestock control fences. These practices should be extended to an additional 20,000 acres by 1980, 40,000 acres by 2000, and 60,000 acres by 2020.

Other Land

Population is projected to increase from 1,768,100 to 4,448,100 by 2020. The land needed for other uses, mostly urban, industrial, and roads is expected to increase from 1,321,600 to 1,737,300 acres. There is a demand for waterfront homes, view properties, and special use. Special use properties may provide access to the Sound for boating, a rural setting for livestock hobbies, nature trails, and many others.

Water needs for all uses will increase in relation to population growth and disposable income. There are 114 watersheds which need water for municipal, industrial and rural domestic use or water quality control.

Flood protection is needed on almost 40,000 acres. There is a need for drainage systems in many urban areas. Drainage is also required to protect foundations of commercial buildings and heavy industrial structures.

Erosion control is needed to protect water and water impoundments from sediments and on all construction sites.

The beaches of Puget Sound are probably the most frequently visited areas in the subregion. Protection of these beaches from erosion, debris, and pollution is needed to insure their continued and increased use.

MEANS TO SATISFY NEEDS

Alternate ways of satisfying future demands for water conservation, drainage, erosion control, and flood prevention are discussed in this section. Most of this section is devoted to a discussion of solutions by the target dates 1980, 2000, and 2020.

Frequently the most effective means to satisfy land treatment needs is to apply practices by cooperative efforts of the landowners. Study reveals 110 of the 122 watersheds require cooperative planning and development. Practice requirements and number of watersheds are shown by time periods in table 485 and suggested progress of development illustrated on figure 71.

Table 485 - Practices Required for Cooperative Conservation Development, Subregion 11

Target Date	No. of Watersheds	Flood Prevention	Erosion Control	Drainage	Potential Irrigation	Land Treatment
1980	25	179.3	5.6	160.1	114.6	345.0
No. Watersheds		25	20	25	25	25
2000	59	67.8	7.9	63.5	117.3	139.2
No. Watersheds		35	22	49	35	49
2020	26	298.2	20.6	11.7	18.8	35.5
No. Watersheds		18	14	21	15	21
Total	110	545.3	34.1	235.3	250.7	519.7
No. Watersheds		78	56	95	75	95

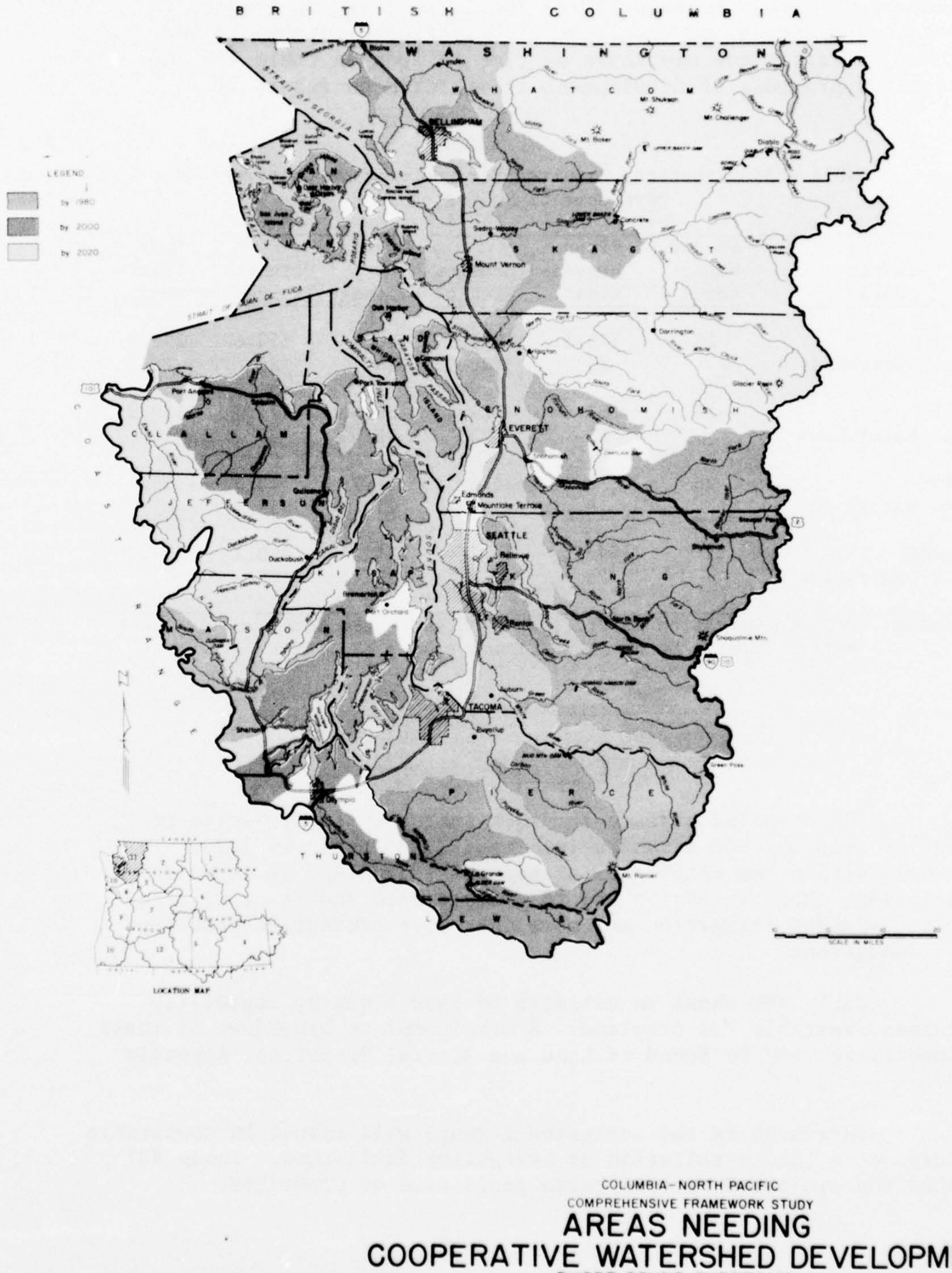
Source: Soil Conservation Service, C-NPRBS and Puget Sound and Adjacent Waters Type 2 Study Projections.

Cropland

The cropland acreage for this subregion is projected to decline from 591,000 acres in 1966 to 385,000 acres by 2020. This is well within the total area of potential cropland as shown in table 486. More intensive use to produce food and fiber will require expanded irrigation and more intensive protective practices and management.

Table 486 shows an estimate of land areas by capability classes, suitable for cropland. A more complete breakdown of these capabilities can be found in Land and Mineral Resources, Appendix IV.

Increases in the irrigated acreage will result in comparable increase in the installation of irrigation facilities. Table 487 shows the projected rate of these facilities or practices.



COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

PUGET SOUND, SUBREGION II

1968

FIGURE 71

Table 486 - Land Areas Suitable for Crop Production
Subregion 11, 1966

Capability Class 1/	Area 1,000 Acres	Percent
I	--	--
II	315.0	15
III	521.0	25
IV	1,231.0	60
Total	2,067.0	100

1/ Discussed, Appendix IV, Land and Mineral Resources
Source: Soil Conservation Service, C-NPRBS Data.

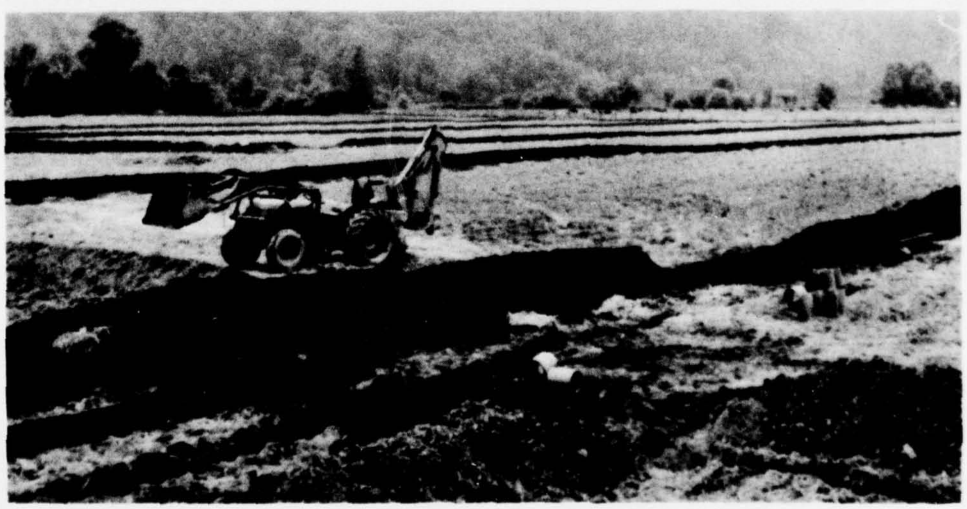
Nearly 80,000 acres of pasture are currently being irrigated by sprinklers in the Puget Sound area. (SCS RO-443-5)

Table 487 - Cumulative Projected Practices for Irrigated Cropland, Subregion 11

Practice	Units	1966	1980	2000	2020
Water Control Facilities	No.	286	2,500	4,250	6,000
Irrigation Water Conveyance	Miles	18	25	35	46
Water Storage Facilities	No.	320	530	950	1,370
Irrigation System, Surface	No.	40	-	-	-
Irrigation System, Sprinkler	No.	2,210	3,080	4,840	6,600
Land Shaping	1000 Acs.	8	10	12	14
Irrigation Water Management	1000 Acs.	92	138	181	223

Source: Soil Conservation Service, C-NPRBS Data

New irrigation is expected to continue to be developed, predominately by individual farmers with some small group developments as well as a few project type developments. Water is available from streams and ground water for nearly 230,000 acres. The inclusion of water for irrigation in project developments can meet needs in numerous areas.



The installation of underground tile removes land use restrictions caused by wetness. (SCS 0-1306-8)

Drainage

Drainage practices should be applied on 347,000 acres by 2020 to meet crop requirements. Table 488 shows the drainage practices that will be necessary to drain these cropland areas to help meet food and fiber needs.

Table 488 - Cumulative Practices Required to Provide Needed Drainage, Subregion 11

Practice	Unit	1966	1980	2000	2020
Drainage Conduits and Ditches	Miles	2,445	2,540	2,676	2,812
Drainage Structures	No.	274	746	1,183	1,520

Source: Soil Conservation Service, C-NPRBS Data

Erosion and Sedimentation

The general nature of measures required to prevent erosion of farmed lands consist of crop rotations to maintain water intake rates and water-holding capacities of the soils. Winter cover crops are essential in this subregion, to protect the soil from the usual excessive rainfall and stream overflow.

Winter cover-crop and summer mulch control erosion on sloping areas. (SCS W2023-2)

Of the land now in cultivation 294,000 acres have a major erosion potential. About 275,000 acres will need protection by 2020. Table 489 shows the practices that are necessary to treat those areas as well as maintain other areas in a stable condition.

Table 489 - Cumulative Required Practices to Satisfy Erosion Control Needs, Subregion 11

Practice	Unit	1966	1980	2000	2020
Grade Stab. Structures	No.	9	10	13	16
Ditch Bank Seeding	Miles	32	36	42	49
Field Windbreak	Miles	1	2	3	4
Crop Residue Use	1000 Acs.	32	46	66	88
Cover & Green Manure Crops	1000 Acs.	24	30	36	41
Cons. Cropping System	1000 Acs.	211	243	295	350
Pasture & Hayland Planting	1000 Acs.	5	14	34	54

Source: Soil Conservation Service, C-NPRBS Data

Flooding

Flood control work is expected to increase greatly in the future to aid in development of the area. Tide gates will be used for flood prevention from tidal action and strong winds; pumps will be used to remove inflow of fresh water when the tide gates are closed. Dikes and levees will be added and enlarged to prevent bank overflow; pumps will be used to prevent flooding from inflow behind the dikes and levees.

Table 490 shows the cropland flood prevention work that is required to reduce local flooding on part of 277,000 acres that flood frequently.

Table 490 - Cumulative Cropland Flood Prevention Practices, Subregion 11

Practice	Unit	1966	1980	2000	2020
Stream Channel Improvement	Miles	87	100	130	160
Streambank Protection	Miles	41	125	220	305
Stream Channel Stabilization	Miles	5	9	15	21
Dikes and Levees	Miles	273	310	365	420

Source: Soil Conservation Service, C-NPRBS Data

Program Costs

The costs of implementing conservation practices discussed in the previous sections are given in table 491 based on 1969 dollars.

Table 491 - Estimated Cost of Cropland Conservation Practices, Subregion 11

Item	Water Conservation	Drainage	Erosion Control	Flood Control	Total
			1000 Dollars		
1966-1980					
Private Funds	61,018	43,122	313,354	4,265	421,759
Public Funds	3,262	31,762	13,056	9,063	57,143
Technical Cost 1/	1,542	14,078	21,217	853	37,690
Total	65,822	88,962	347,627	14,181	516,592
1981-2000					
Private Funds	122,795	66,942	426,144	7,455	623,336
Public Funds	6,565	49,306	17,756	15,841	89,468
Technical Cost 1/	3,105	21,855	28,854	1,491	55,305
Total	132,465	138,103	472,754	24,787	768,109
2001-2020					
Private Funds	155,069	67,648	346,176	18,135	587,028
Public Funds	8,291	49,827	14,424	38,537	111,079
Technical Cost 1/	3,921	22,085	23,439	3,627	53,072
Total	167,281	139,560	384,039	60,299	751,179

1/ Includes public and private costs
Source: Soil Conservation Service, C-NPRBS Projections

Forest Land

Forest land management practices are becoming more intensified as the old-growth stands are cut over and urban expansion converts forest land to non-forest uses. This, along with increasing recreation demands, will cause mounting pressures on the remaining forest land to meet projected timber production demands. These pressures will require accelerating levels of watershed protection, reduction in present sediment levels, and the augmentation of flows by methods of vegetation and snowfield management.

Watershed Protection

It is anticipated that the watershed protection practices as outlined in table 471, will parallel the rise in the subregion's timber harvest activities. This level of protection should be maintained on the public forest land, particularly on those more critical areas outlined in figure 70, the Potential Erosion Hazard Map. Watershed protection practices on the private forest lands must be accelerated to that level presently attained on the public lands to maintain present water quality. Table 492 outlines the future anticipated watershed protection practices and the total cost of such measures, accumulated through the year 2020. These costs are based on the assumption that: (1) On the public forest lands, controls through timber sales and construction contracts are adequate if properly applied, and (2) on the private forest lands, the minimum required in the year 2020 will be about equal to that presently accomplished on the public lands.

Table 492 - Projected Costs for Watershed Protection Practices, Forest Land, Subregion 11

Practices	Unit	Total Units 1/	Total Cost 1/ $1000
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	58,000	1,740
Harvest Road Treatment 2/	Mi.	8,100	2,025
Other Watershed Requirements 3/	Ac.	3,546,000	77,970
Total Cost			81,735
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	123,000	3,075
Harvest Road Treatment	Mi.	17,300	3,460
Other Watershed Requirements	Ac.	2,871,000	96,446
Total Cost			102,981
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	181,000	4,815
Harvest Road Treatment	Mi.	25,400	5,485
Other Watershed Requirements	Ac.	6,417,000	174,416
Total Cost			184,716

1/ Total for 55 year period 1965-2020. Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, timber cultural practices, and other indirectly related items.

At the rate projected in table 492, recurrent watershed protection measures will cost about $1,490,000 annually on the public forest lands and should cost $1,870,000 annually on the private. This annual recurrent cost of the existing watershed protection programs, extended from 1965 to 2020 amounts to $184,716,700. This is the total cost required to maintain the productive condition of forest watersheds under the pressure of the projected demands.

Watershed Rehabilitation

The forest lands most in need of rehabilitation are scattered throughout the entire forest area. These are critical sediment source areas found within the general area of low yields shown on table 471. Table 493 lists these acreages and the amounts that should be treated during time periods 1980, 2000, and 2020. Table 494 outlines the expected sediment reduction through application of these measures.

The overall expected decrease in sediment yield is 20 acre-feet per year, or about 2 percent of present annual yields. Although this is a relatively low subregional average, it does represent reduction of a major portion of the sediment produced by land use activities. The work will have its greatest effect in localized areas, particularly in the case of stream clearance and streambank protection. This is of extreme importance to the protection of anadromous fish spawning areas, a major resource of the subregion.

In addition to the needs for sediment reduction on the presently eroding forest lands, nonrecurrent work will be required on future burned-over forest areas and lands directly related to future water storage projects. These sediment sources will be treated as they are required. Therefore, the 2 percent annual sediment reduction is that amount possible should no new sources occur through catastrophic fire or other natural disaster.

Water Yield Improvement

Snowpack management, timber type conversion, and water spreading are all projected water yield improvement techniques proposed for the subregion. All three management practices will help stabilize streamflows by reducing peaks and extending low flows through the late summer and fall.

Table 493 - Projected Watershed Rehabilitation Programs, Forest Land, Subregion 11

Program	Unit	1980 Amount	1980 Cost 1/ $1000	2000 Amount	2000 Cost 1/ $1000	2020 Amount	2020 Cost 1/ $1000
FEDERAL LANDS 2/							
Land Treatment	Ac.	5,700	1,101	8,000	3,346	7,900	3,206
Stream Rehabilitation	Mi.	225	3,430	310	3,750	310	3,750
Road Rehabilitation	Mi.	90	126	120	166	120	166
Total Cost			4,657		7,262		7,122
NON-FEDERAL LANDS							
Land Treatment	Ac.	11,100	888	11,200	896	11,200	896
Stream Rehabilitation	Mi.	160	640	215	860	215	860
Road Rehabilitation	Mi.	220	11	280	15	280	15
Total Cost			1,539		1,771		1,771
TOTAL ALL LANDS							
Land Treatment	Ac.	16,800	1,989	19,200	4,242	19,100	4,102
Stream Rehabilitation	Mi.	385	4,070	525	4,610	525	4,610
Road Rehabilitation	Mi.	310	137	400	181	400	181
Total Cost			6,196		9,033		8,893

1/ In 1969 dollars.
2/ Data from Puget Sound Type 2 Study with minor adjustments.

Table 494 - Expected Annual Sediment Reduction Forest Land Rehabilitation, Subregion 11

Present Yields 1/	Acres (1,000)	Total Sed. Yield Ac.-ft./Yr.	Acres Treated 2/	Sediment Reduction Ac.ft./Yr.
Very low	--	--	--	--
Low	6,373.2	996	165,000	20.6
Medium	55.8	17	--	--
High	--	--	--	--
Very high	--	--	--	--
Total	6,429.0	1,013		20.6
		Total reduction, percent 2		

1/ Data from table 470

2/ Data from table 491. Miles treated converted to acres.

The projected water yield improvement programs needed and the amount that should be accomplished during time periods 1980, 2000, and 2020 are listed in table 495. As previously discussed in other subregions, the timber cover on private forest land is modified principally by log production requirements. Therefore, neither water yield improvement practices nor benefits are estimated, although some benefit does occur.

Table 495 - Projected Water Yield Improvement Practices, Public Forest Land, Subregion 11 1/

Program	Unit	1980 Amount	1980 Cost 2/ $1000	2000 Amount	2000 Cost 2/ $1000	2020 Amount	2020 Cost 2/ $1000
Cover Manipulation 3/	Ac.	1,000	10	41,000	408	41,000	408
Snowpack Management	Mi.	50	2,500	800	40,000	800	40,000
Water Spreading 4/	Ac.	4,200	17	5,300	22	4,300	17
Total Cost			2,527		40,430		40,425

1/ Data from Puget Sound Type 2 Study with minor adjustments
2/ In 1969 dollars.
3/ Includes type conversion and riparian vegetation management
4/ Planned for altering timing of runoff or groundwater recharge, not for irrigation or other resource activity.

Total Program Costs

In summary, the total cost of forest watershed protection and land treatment programs through the year 2020 may be expressed as follows:

	Cost ($1,000)
Watershed Protection	184,716
Watershed Rehabilitation	24,122
Water Yield Improvement	83,382
	292,220

Rangeland

Measures and Practices for Watershed Protection

Required future measures for range watershed protection and improvement which are shown on tables 496, 497 and 498 have other management objectives as well as improving the watershed.

Table 496 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Subregion 11 1/

Measures & Practices	Units	Land Ownership			Watershed Purposes 2/			
		Public 3/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	-	1,500	1,500	-	x	x	x
Brush Control	Acres	-	3,000	3,000	-	x	x	-
Fertilizing	Acres	100	100	200	-	-	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	5	60	65	x	x	x	-
Livestock & Game Water Facilities	Number	-	100	100	-	x	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	5	50	55	x	x	x	x
	Acre Ft.	5	50	55	x	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County, and Municipal Ownership.

Table 497 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1981 to 2000, Subregion 11 1/

Measures & Practices	Units	Land Ownership			Watershed Purposes 2/			
		Public 3/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	-	2,000	2,000	-	x	x	x
Brush Control	Acres	-	3,000	3,000	-	x	x	-
Fertilizing	Acres	100	100	200	-	-	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	5	60	65	x	x	x	-
Livestock & Game Water Facilities	Number	-	100	100	-	x	x	-
Water Control Structures								
Ponds and Small Reservoirs	Number	5	50	55	x	x	x	x
	Acre Ft.	5	50	55	x	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County, and Municipal Ownership.

Table 498 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2001 to 2020, Subregion 11 1/

Measures & Practices	Units	Land Ownership			Watershed Purposes 2/			
		Public 3/	Private	Total	(1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	-	2,000	2,000	-	x	x	x
Brush Control	Acres	-	3,000	3,000	-	x	x	-
Fertilizing	Acres	200	200	400	-	-	x	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	5	60	65	x	x	x	-
Livestock & Game Water Facilities	Number	-	100	100	-	x	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	5	50	55	x	x	x	x
	Acre Ft.	5	50	55	x	x	x	x

1/ Data collected from land management agencies specifically for the C-NP Study.
2/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
3/ Includes Federal, State, County, and Municipal Ownership.

Cover improvement and soil stabilization practices should be applied on an estimated 14,000 acres of rangeland between 1966 and 2020. Revegetation, primarily the establishment of grasses, is needed on 5,500 acres; brush should be controlled on 9,000 acres; and 800 acres should be fertilized. Future requirements include the construction, reconstruction, or repair of about 195 miles of livestock control fence, and the development of some 300 livestock and big game water facilities. Numerous small size parcels of rangeland, and continual shifts in grazing land use, require a relatively large number of water facilities and fence mileage. Many of the areas on which these practices are accomplished may revert to other types of use by 2020.

Erosion and Sediment Yield Improvement

Improvement is anticipated in the condition of some of the eroding areas producing higher sediment yield. The projected sediment yield is shown on table 499 with a decrease of 12 percent by 2020. This is due in part to watershed management practices and in part to a reduced rangeland acreage.

Improved Range Condition and Capacity

The estimated future range condition is shown in table 500. By 2020, about 17 percent will be in good range condition, 35 percent in fair condition, and 48 percent in poor condition, about the same condition that existed in 1966. The grazing capacity of 15,200 animal unit months in 1966 is expected to decrease to 13,300 animal unit months by 2020, corresponding roughly to the decrease in total acreage.

Estimated Program Costs

Investment cost estimates are shown on table 501 for watershed protection and rehabilitation of rangeland. Cover improvement and soil stabilization practices will require $84,500 between 1966 and 2020, about 30 percent of the total watershed program costs of $282,200. Watershed oriented land management costs amount to $90,800 or 32 percent of total program costs and $106,900 or 38 percent is needed for water control structures.

Table 499 - Sediment Yield Projections from Rangeland
Subregion 11

Sediment Yield Categories 1/	1966	1980	2000	2020
		Rangeland Acreage (1,000 Acres)		
Very Low	-	-	-	-
Low	103.1	103.1	98.2	90.3
Medium	1.9	1.9	1.8	1.7
High	-	-	-	-
Very High	-	-	-	-
Total	105.0	105.0	100.0	92.0
Percent Change from 1966	.0	.0	-4.8	-12.4
		Annual Sediment Yield (Acre-feet)		
Very Low	-	-	-	-
Low	24	24	23	21
Medium	1	1	1	1
High	-	-	-	-
Very High	-	-	-	-
Total	25	25	24	22
Percent Change from 1966	0	0	-4	-12

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.

Table 500 - Estimated Potential Rangeland Improvement, Subregion 11

Range Type and Condition	1966		1980		2000		2020	
	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)	Acres (1,000)	AUM's (1,000)
Grassland								
Good	10.1	4.2	10.1	4.2	9.6	4.0	8.9	3.7
Fair	32.7	5.5	32.7	5.5	31.2	5.2	28.6	4.8
Poor	20.4	1.6	20.4	1.6	19.4	1.5	17.9	1.3
Seeded Range	2.5	1.2	2.5	1.2	2.4	1.2	2.2	1.1
Total	65.7	12.5	65.7	12.5	62.6	11.9	57.6	10.9
Sagebrush								
Good	-	-	-	-	-	-	-	-
Fair	-	-	-	-	-	-	-	-
Poor	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-
Other Brush								
Good	5.1	1.1	5.1	1.1	4.8	1.1	4.4	1.0
Fair	4.1	.4	4.1	.4	3.9	.4	3.6	.4
Poor	30.1	1.2	30.1	1.2	28.7	1.1	26.4	1.0
Total	39.3	2.7	39.3	2.7	37.4	2.6	34.4	2.4
Total								
Good 1/	17.7	6.5	17.7	6.5	16.8	6.3	15.5	5.8
Fair	36.8	5.9	36.8	5.9	35.1	5.6	32.2	5.2
Poor	50.5	2.8	50.5	2.8	48.1	2.6	44.3	2.3
Grand Total	105.0	15.2	105.0	15.2	100.0	14.5	92.0	13.3
Average AC/AUM	6.9		6.9		6.9		6.9	
Percent Change from 1966	.0	.0	.0	.0	-4.8	-4.7	-12.4	-12.4

1/ Includes seeded range.
Source: Table 474 - "Present Status" rangeland narrative. Future estimates for this study are based on representative on-site surveys for production guides with consideration to the capability of the range for improvement with proper management and utilization.

Table 501 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs, Subregion 11 1/

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
		Public Land		
Cover Improvement and Soil Stabilization	.1	.1	.3	.5
Watershed Oriented Land Management Practices	1.8	1.8	1.7	5.3
Water Control Structures	3.2	2.8	3.7	9.7
Total	5.1	4.7	5.7	15.5
		Private Land		
Cover Improvement and Soil Stabilization	25.6	29.1	29.3	84.0
Watershed Oriented Land Management Practices	28.5	28.5	28.5	85.5
Water Control Structures	32.4	27.8	37.0	97.2
Total	86.5	85.4	94.8	266.7
		Total		
Cover Improvement and Soil Stabilization	25.7	29.2	29.6	84.5
Watershed Oriented Land Management Practices	30.3	30.3	30.2	90.8
Water Control Structures	35.6	30.6	40.7	106.9
Total	91.6	90.1	100.5	282.2

1/ Based on measures and practices shown on tables 496, 497, and 498 with constant 1969 dollars.

Other Land

The conversion of agricultural and other open land to urban, industrial, and other non-agricultural uses points up the need for more intensive and comprehensive planning to meet future needs. An essential part of the planning will be for erosion reduction, floodwater protection, drainage, pollution abatement, improved transportation, and enhancement of esthetic values. Coordinated planning by all levels of government and private interests can best accomplish the needs for natural resource development. Urban interests can best be served by including the agricultural industry in planning for other uses of land, inasmuch as farming usually is the principal use of land adjoining many urban developments.

Protection for other land that is presently flooded can be enhanced by flood detention reservoirs, enlarged or improved channels, and by dikes and levees. During urban construction, debris basins can be provided to prevent silt and debris from leaving the construction site.

Millions of dollars are spent annually to protect property from flooding, provide drainage, and to develop natural resources. The Puget Sound and Adjacent Waters Type 2 Study projections total $900 million for drainage of urban and rural non-farm lands by 2020. This does not include outlets for storm surface waters. These costs are probably greater than most subregions. Most measures and practices required to satisfy needs for other land have been included and costed in other sections of this appendix and in Appendix VII, Flood Control; IX, Irrigation; XI Municipal and Industrial Water Supply; and XII, Water Quality and Pollution Control.

Soil surveys and interpretive maps of the surveys provide a basis for a more economical expansion of urban land uses. These soil surveys indicate the hazards of use for certain developments and possible ways to overcome the problems.

Soil erosion and sediment control practices such as sediment basins, grass seedings, woody plantings, diversions, considerations for minimal soil disturbances will be needed with contractual requirements for erosion control on construction jobs.

LOCATION MAP

SUBREGION 12

S U B R E G I O N 1 2

O R E G O N C L O S E D B A S I N

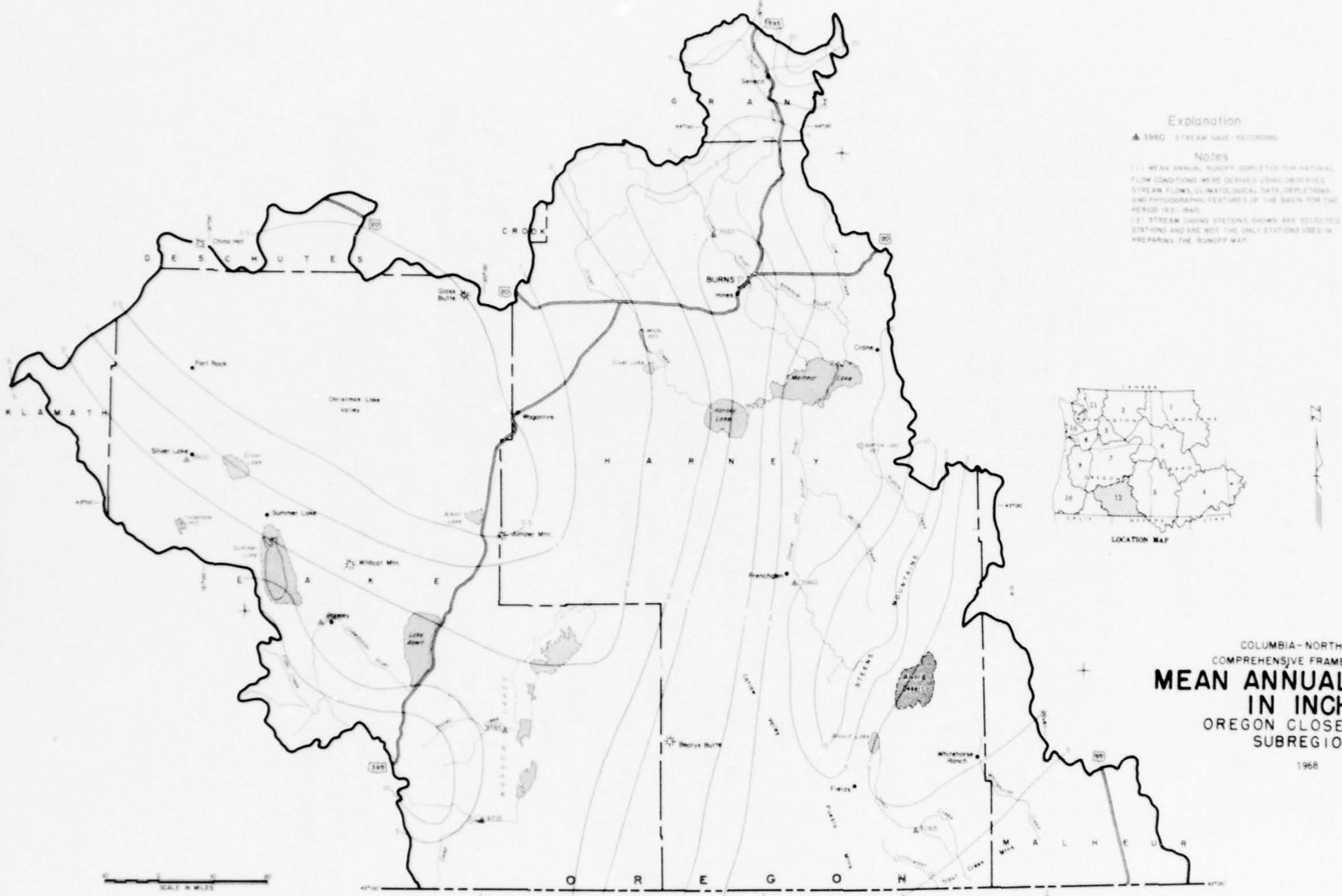
PRESENT STATUS

Subregion 12 embraces 11.5 million acres in the south-central part of Oregon and represents 6.5 percent of the Region. This includes a land area of 11.4 million acres and a water area of under 100,000 acres. The subregion is 76 percent publicly owned, consisting mainly of Bureau of Land Management administered grazing areas. Rangeland accounts for 77 percent of the land area as shown in figure 72 and table 502.

Precipitation varies considerably with the mountainous areas on the west receiving over 30 inches of precipitation, while some of the lower areas have less than 10 inches annually. About 55 percent of the annual total falls between November and March and only about 15 percent from June through August. Despite the relatively cool winter temperatures, winter precipitation occurs frequently as rain over most of the area with only about 40 percent of the precipitation occurring as snow. However, in higher elevations as much as 65 percent of the average annual precipitation occurs as snow. The average low temperatures are cool with freezing occurring from 175 to 275 days annually. The average frost-free period varies from 82 days at Silver Lake to 120 days in Warner Valley. However, a subfreezing temperature may occur any month of the year.

Total runoff originating in the subregion amounts to only 1.2 million acre-feet annually. It is distributed by elevation with the highest flows coming from the mountainous areas (figure 72).

Sediment yields are generally low, and correspond to periods of high runoff. Highest yields come from the range areas (table 502 and figure 74).



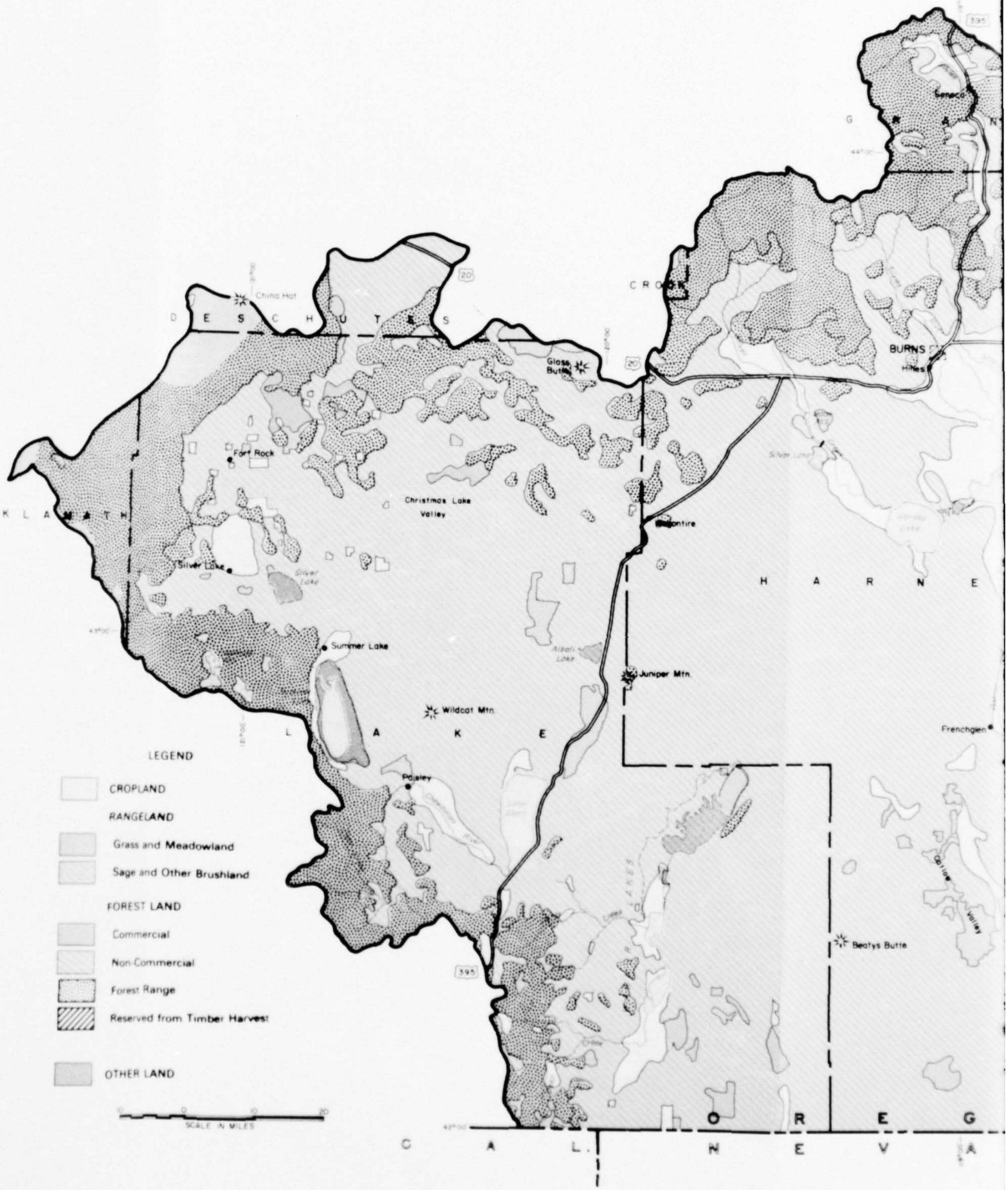
COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL RUNOFF IN INCHES

OREGON CLOSED BASIN
SUBREGION 12

1968

FIGURE 72



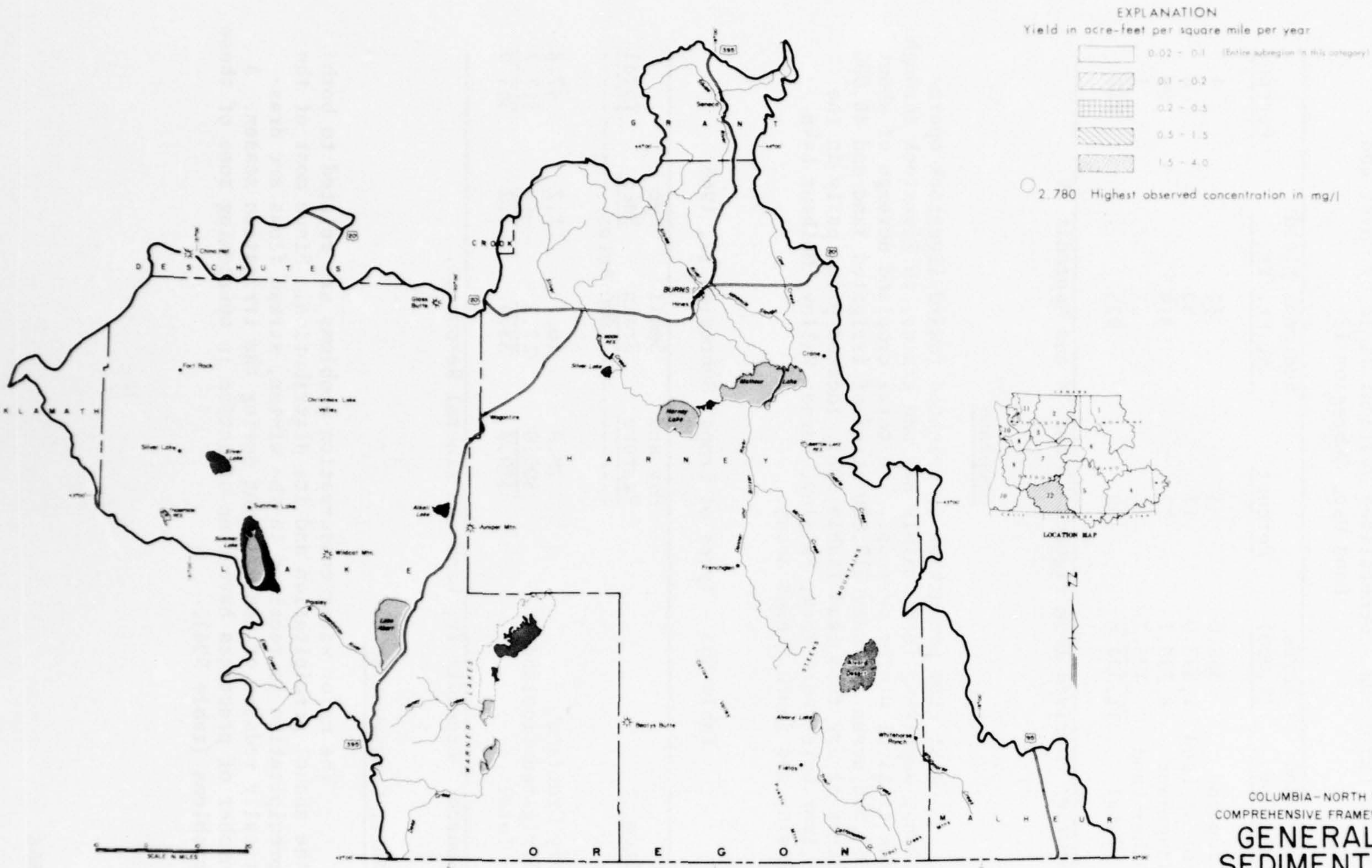
D E S C H U T E S
C R O O K
G R A N
K L A M A T H
L A K E
H A R N E
C A L.
N E V A
O R E G
China Hat
Glass Butte
BURNS
Hines
Seneca
Fort Rock
Christmas Lake Valley
Silver Lake
Summer Lake
Alkali Lake
Juniper Mtn.
Wildcat Mtn.
Paisley
Frenchglen
Beatys Butte
20
395
LEGEND
CROPLAND
RANGELAND
Grass and Meadowland
Sage and Other Brushland
FOREST LAND
Commercial
Non-Commercial
Forest Range
Reserved from Timber Harvest
OTHER LAND
SCALE IN MILES

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED COVER AND LAND USE

OREGON CLOSED BASIN
SUBREGION 12
1968

FIGURE 73



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

GENERALIZED SEDIMENT YIELD

OREGON CLOSED BASIN
SUBREGION 12
1968

FIGURE 74

Table 502 - Generalized Sediment Yield by Cover and Land Use, Subregion 12

Cover and Land Use	Acres (1,000)	Percent	Sediment Yield Ac.Ft./Yr.	Percent
Cropland	365.0	3	34	4
Forest Land	1,893.0	17	59	6
Rangeland	8,733.1	77	819	89
Other Land	403.7	3	13	1
Total	11,394.8	100	925	100

Source: Derived from figures 73 and 74 and Appendix IV.

Cropland

Most crop production is oriented toward livestock operations, supplying feed, mainly hay and grains, to livestock through the critical winter periods. The total cropland acreage of about 365,000 acres includes 317,000 acres of irrigated land and 48,000 acres of dry farm land (table 503), located principally in the Silver Lake, Fort Rock, Paisley, Warner Valley, Malheur Lake Basin, and South Steens areas.

Table 503 - Types of Crops, Subregion 12, 1966

Item	Hay and Pasture	Small Grain	Rye Seed	Total
	-------------1000 Acres-------------			
Dry Cropland	29.9	16.7	1.2	47.8
Irrigated Cropland	300.0	17.2	--	317.2
Total	329.9	33.9	1.2	365.0

Source: Appendix IV, Land and Mineral Resources.

Water Conservation

The major water conservation problems are related to both the annual precipitation and its distribution. Since most of the precipitation is received in the winter, stream flows are drastically reduced or non-existent during the irrigation season. A number of practices have been effective in overcoming some of these problems (table 504).

Table 504 - Water Conservation Practices Applied on Cropland Through 1966, Subregion 12

Practice	Unit	Amount
Water Control Facilities	No.	3,480
Irrigation Water Conveyance Facilities	Miles	1,560
Water Storage Facilities	No.	44
Irrigation Systems, Surface & Subsurface	No.	7,800
Irrigation Systems, Sprinkler	No.	127
Land Shaping	1000 Acres	41
Irrigation Water Management	1000 Acres	16

Source: USDA Soil Conservation Service Data.

Since dryland crops are marginal, cropland development depends upon the availability of irrigation water. However, the very scarce water supply is a critical factor in further development. Industrial development does not compete with agriculture for the water supplies.

The irrigated areas around Silver Lake and Fort Rock are located on ancient lake beds. Water for the Silver Lake area is obtained from stream diversions and storage from the Thompson Reservoir. Water supplies are adequate 70 to 80 percent of the time. Streams supply most of the water for irrigation in the Fort Rock Valley. The predominant water management problem is caused by sandy soils which make conveyance of water and efficient flood irrigation difficult. Wells are also an important source of irrigation water in these areas.

The Paisley irrigated area is on a dry lake bed with a few fields on the alluvial fans just above the lake bed. Most water is obtained from streamflow of the Chewaucan River, which has relatively high flows in late winter and spring. Large areas are irrigated in the spring, but the acreage decreases as the flow drops. There are a small number of irrigation wells in the area.

The irrigated areas in Warner Valley are mostly on the dry lake bed and on some bottomland areas along Twentymile and Deep Creeks, with a small amount on an alluvial fan at Plush. The tributary streams flowing into this valley follow one pattern of high spring flows and have low summer flows. Two lakes, Greaser and Hart, are used to supplement streamflow.

Fan, terrace, and flood plain soils are irrigated in Malheur Lake Basin area. Hay and pasture land is irrigated by

streamflow diverted from several sources. Here, the water conservation problems are related to the alkaline soils and the type of irrigation used.

Streamflow provides most of the irrigation water for the production of hay and pasture on fan and flood plain soils in the south Steens area.

The present status of water availability and irrigation use is shown in table 505. Interpretation of data presented in the table reveals that there are two common problems associated with irrigation: Inadequate supply, and an inefficient method of application.

There are many problems associated with the diversion and conveyance of irrigation water to the several areas discussed above. The major problems are: (1) Frequent damage to diversion dams by flood waters, (2) maintenance problems on over 420 miles of canals, and (3) high seepage losses in sandy soil areas. Since existing irrigation developments have generally been individual

Table 505 - Water Availability and Irrigation Use, Subregion 12, 1966

Item	Area 1000 Acres
Water Source	
Streamflow	278.6
Ground water	14.1
Reservoir Storage	24.5
Total	317.2
Area with Adequate Supply	47.7
Area with Inadequate Supply	269.5
Method of Application	
Sprinkler	5.6
Flooding	311.6

Source: USDA, Soil Conservation Service River Basin Data.

efforts, problems that appear to be relatively minor may cripple an entire distribution system. More effective structures are needed, but economic factors (due in part largely to the individual ownership) limit the rehabilitation and improvements of the systems.

Drainage

With the present wild flooding method of winter and early spring irrigation, drainage is a critical problem in parts of the subregion. It is estimated that 134,000 acres (49 percent) of cropland have a drainage problem, with over 94,000 acres in low lying or nearly level areas where outlets for drainage systems are inadequate (table 506). Drainage problems are caused mainly by spring runoff or irrigation of hardpan soils. In addition, poor drainage has contributed to alkali and boron concentrations in many cropland areas. The only solution is adequate drainage.

Table 506 - Cropland Areas with a Wetness Problem
Subregion 12, 1966

Capability Class	Area 1000 Acres
II	3
III	102
IV	29
Total	134

Source: Soil Conservation Service, C-NPRBS Data.

Based on data available from Grant and Lake Counties, it has been estimated that approximately 80,000 acres have been drained in this subregion. Total accomplishment of this work is shown in table 507.

Table 507 - Drainage Practices Applied to Cropland,
Subregion 12, 1966

Practice	Unit	Amount
Conduits and Ditches	Miles	243
Structures	No.	2

Source: USDA Soil Conservation Service Data.

Erosion and Sedimentation

About 82,000 acres of cropland have an erosion potential. However, only about 10 percent, mostly dry cropland, presently has a severe problem. Erosion of irrigated land is not a problem since most of these lands are protected by a cover of legumes or

Bank erosion gradually destroys the most productive soils. Land destroyed and soils lost in this way cannot be reclaimed. Sediments from these areas can damage down stream areas. (SCS 0-994-7)

Sedimentation removal from roads and road ditches is expensive, causes hazards, and reduces or restricts essential transportation. (SCS 0-1738-11)

grasses. The exceptions occur during periods of inundation by flood waters and during establishment of a new stand. Where flood-waters cross cropland, gullies are sometimes formed or the topsoil is stripped from around the plant roots. Establishing a new stand of grass or legume requires that the soil be bare for a short period during which time intense precipitation or improper irrigation can severely erode this bare soil. Sprinkler irrigation is used frequently in establishing new stands. Cropland areas with an erosion potential are shown in table 508.

Table 508 - Cropland Areas with an Erosion Potential, by Capability Class, Subregion 12, 1966

Capability Class	Area 1000 Acres
II	8.0
III	25.0
IV	49.0
Total	82.0

Source: Soil Conservation Service, C-NPRBS Data.

Considerable work has been done to control erosion on cropland. Table 509 shows the total accomplishments, based on estimates made from data available for Lake and Grant Counties.

Table 509 - Erosion Control Practices Applied on Cropland, Subregion 12, 1966

Practice	Unit	Amount
Grade Stabilization Structures	No.	184
Diversions and Terraces	Miles	50
Ditch Bank Seeding	Miles	8
Field Windbreak	Miles	2
Crop Residue Use	1000 Acres	32
Stubble Mulch	1000 Acres	6
Strip cropping	1000 Acres	6
Conservation Cropping System	1000 Acres	38
Pasture and Hayland Planting	1000 Acres	24

Source: USDA Soil Conservation Service Data.

Flooding

Floods originate principally from snowmelt and are most likely to occur in March, April, and May. Flooding also results from early spring rains or snowmelt while the ground is frozen. Cropland along the main rivers and tributary streams is subject to overflow during high runoff periods. Damage to cropland is minimized, however, because all lands subject to flooding are in sod-forming crops, and most floods occur prior to the time the land is prepared for seeding. Still 120,000 acres are flooded

Inadequate surface water disposal systems cause large areas to frequently inundate. (SCS 0-1698-2)

at least once in 5 years. Total average annual flood damages are estimated to be nearly \$1.5 million in Appendix VII, Flood Control. Much of the damage is caused by sediment to structures and stream channels. Major measures and practices needed to correct the flood situation on cropland are required on upstream watershed areas discussed in the range and forest sections. Table 510 shows the practices applied primarily for flood prevention.

Table 510 - Flood Protection Measures Applied in Cropland Areas, Subregion 12, 1966

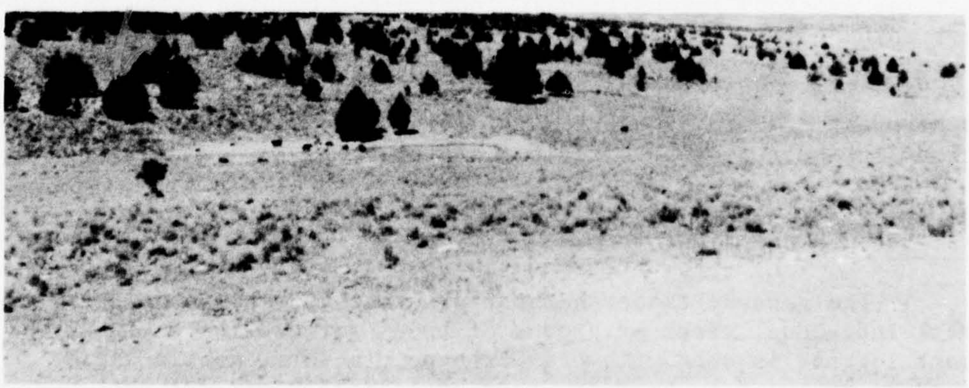
Practice	Units	Miles
Stream Channel Improvements	Miles	53
Dikes and Levees	Miles	51
Streambank Protection	Miles	26
Stream Channel Stabilization	Miles	1

Source: USDA Soil Conservation Service Data.

Forest Land

Forests cover 1.9 million acres or 17 percent of the total land area in the subregion. About 81 percent is in public ownership and 19 percent is in private. Seventy-four percent of the area is commercial forest land and 26 percent is noncommercial.

The commercial land currently supports nearly 17 billion board feet of merchantable timber, 79 percent on public land and 21 percent on private. This area furnishes the raw material for the subregion's forest products industry, which accounts for 97 percent of the manufacturing employment. In 1964, a timber harvest of 340 million board feet was recorded. In addition, this area is heavily used by domestic livestock. The noncommercial forests,



Livestock use on noncommercial forest range. These cattle are gathering at a stock watering pond in arid juniper grassland. (SCS 7-1985-3)

mostly juniper-grasslands, cover nearly one-half million acres and are some of the best grazing lands in the subregion.

Although only 17 percent of the subregion is forested, nearly 43 percent of its runoff originates there. The major use of this runoff is for irrigation supplies. These flows are also responsible for most of the flooding damage in local urban areas.

The forest lands of the subregion have the lowest sediment yields in the region. Average sediment production is about 60 acre-feet per year or 6 percent of the subregion's total sediment yield (table 511).

Table 511 - Present Sediment Yield, Forest Land, Subregion 12

Sediment Yield Category	Acres (1,000)	Percent	Annual Sediment Yield Acre-Feet Per Square Mile	Annual Sediment Yield Total Acre-Feet	Percent
Very low	1,893.0	100	0.02 - 0.1	59	100
Low	--	--	0.1 - 0.2	--	--
Medium	--	--	0.2 - 0.5	--	--
High	--	--	0.5 - 1.5	--	--
Very High	--	--	1.5 - 4.0	--	--
Total	1,893.0	100		59	100

Source: Derived from figures 73 and 74.

Nearly all of the forest land is in the very low yield category. Sediment from these areas is principally the result of natural erosion, intensified in local areas by high intensity summer rain storms. There are localized problems, however, both resulting from past logging and grazing. Some action has been taken to restore these watersheds to a good condition. Most current practices are aimed at maintaining the balance of the forested areas in their current excellent state.

Watershed Protection

The general timber harvest practice in the subregion is to mark individual trees or groups of trees for cutting. Although most logging is done with crawler-type tractors, mobile cable yarders are used to harvest occasional small clear-cut settings in dense even-aged lodgepole and fir stands. Tractor trails and temporary roads are generally cross-drained and seeded to grass and legumes to retard runoff and prevent surface erosion. Most logging debris is removed from live streams and major draws to reduce the danger of debris dam washouts which can cause damage to fish habitat and downstream improvements.

Most roads are surfaced and have permanent culverts. End-hauling of excavated materials to suitable waste areas away from stream bottoms is a common practice. Raw cut and fill slopes are seeded to protect them from erosion and the streams from sediment deposition.

Reforestation measures include both planting and direct seeding. Advanced reproduction in the partial cut areas is protected from timber falling and yarding by on-the-ground administrative controls. The harvest activities and protection requirements are summarized in table 512.

Table 512 - Average Annual Timber Harvest Activity, Subregion 12

	Unit	Public	Private	Total
Harvest Area	Acres	12,000	4,000	16,000
Area Reforested 1/	Acres	1,200	400	1,600
Slash Disposal Area	Acres	6,000	800	6,800
Disturbed Area Treated 2/	Acres	1,800	--	1,800
Harvest Road Required	Miles	70	25	95
Harvest Road Treated 3/	Miles	60	--	60

1/ Includes planting, seeding and site preparation. Balance adequately stocked or requires no regeneration work.
2/ Includes seeding, mulching, debris removal and cross-draining skidroads and logging areas.
3/ Cut and fill stabilization only.

Watershed Rehabilitation

The existing erosion problems on forest land are localized, the result of past timber harvesting fires and grazing practices. These areas are contributing a total of about three acre-feet of sediment annually. Most of this results from water movement down abandoned roads and across areas disturbed by logging or overgrazing years ago. Streambank cutting is a serious problem along some streams which have had the protective vegetation destroyed.

Rehabilitation work has been accomplished primarily on National Forest lands. Other public forest ownerships are limited within the subregion. Because private forest ownerships are small and scattered, rehabilitation work has also been limited here. Annual work accomplished on the public lands includes land treatment on about 100 acres and treatment of nearly 100 miles of abandoned roads and trails. Typical of the stream protection measures in the subregion is the bank stabilization work on the Fremont National Forest (table 513).

Streambank protection work along the Chewaucan River. This type of revetment, large-sized gravel contained in wire baskets, holds many cubic yards of loose streamside soil in place. (Forest Service)

Table 513 - Average Annual Accomplishment, Watershed Rehabilitation Practices on Public Forest Land, Subregion 12

Practice	Unit	National Forest 1/	BLM 2/	State Lands 2/
Sheet Erosion Control	Ac.	100	--	--
Gully Stabilization	Mi.	2	--	--
Stream Clearance & Stabilization	Mi.	12	--	--
Existing Road & Trail Rehab. 3/	Mi.	86	--	--
Reservoir Protection	Ac.	--	--	--

1/ Average of period 1964-66.
2/ Minor Ownership.
3/ Includes abandoned roads.
Source: Data furnished by agency as listed.

Water Yield Improvement

Water yield improvement programs are new to the subregion. Accomplishment to date has been limited to experimental cutting practices.

Rangeland

Subregion 12 has 8.7 million acres of rangeland, or 77 percent of all area lands. Seventy-nine percent (6.9 million acres) of the range is in public ownership, including 6.6 million acres of Federal and 274,000 acres of state land. Another 1.8 million acres or 21 percent is in private ownership. Rangeland classes and ownership are discussed in Appendix IV, Land and Mineral Resources. Present rangeland condition and grazing capacity are shown on table 514. Sagebrush is the predominant cover on 85 percent of the rangeland, grass species on 11 percent, and other brush or shrubs on 4 percent. Generally, private lands are in better condition; they account for 21 percent of the total range acreage and 28 percent of the total grazing capacity. The private range requires 6 acres per animal unit month compared with 9 acres per animal unit month for the public range. This area has an estimated annual grazing capacity of 1.1 million animal unit months or 15 percent of the regional total.

Livestock ranching is a dominant activity in the subregion and, through past use, much of the rangeland area has been damaged by overgrazing. Considerable progress has been made in adjusting livestock use to the grazing capacity of the range and excessive grazing use had been reduced on an estimated 4.1 million acres by 1966 (47 percent of the total range). However, 54 percent of the range was still in poor condition then with deficient vegetative cover and unstable soils, causing decreased infiltration rates and increased runoff. There is a serious wind and water erosion problem on about 1.8 million acres, due partly to low precipitation which makes maintenance of an adequate vegetative cover difficult and partly to overgrazing on steeper lands. Streambank erosion may be severe in high velocity parts of streams; gully erosion is prevalent in steeper upper reaches of watersheds where deep soils exist. Wind erosion may be severe in flatter open areas of the high desert. Rangelands produce an average annual sediment yield of about 819 acre-feet (table 515). Although the generalized sediment yield map (figure 74) shows all lands to have an annual sediment yield of 0.1 acre-feet or less per square mile, localized areas have a much higher yield rate. Sediment damage results from flooding, mostly along the lower stream areas when channel gradients are flat and the banks not well defined. Flooding is not a particularly serious problem on rangeland but range use and

Table 514 - Rangeland Condition and Capacity, Subregion 12, 1966

Range Type and Condition	Ownership					
	Public		Private		Total	
	Acres	AUM's	Acres	AUM's	Acres	AUM's
	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)	(1,000)
Grassland						
Good	41.6	15.4	278.9	103.3	320.5	118.7
Fair	48.3	10.1	145.0	30.2	193.3	40.3
Poor	16.6	1.5	80.0	7.3	96.6	8.8
Seeded Range 1/	173.3	66.7	182.6	70.2	355.9	136.9
Total	279.8	93.7	686.5	211.0	966.3	304.7
Sagebrush						
Good	1,043.2	316.1	75.2	22.8	1,118.4	338.9
Fair	1,729.3	157.2	134.6	12.2	1,863.9	169.4
Poor	3,597.9	179.9	875.6	43.8	4,473.5	223.7
Total	6,370.4	653.2	1,085.4	78.8	7,455.8	732.0
Other Brush						
Good	52.6	20.3	10.2	3.9	62.8	24.2
Fair	101.1	25.2	26.7	6.7	127.8	31.9
Poor	64.0	5.3	56.4	4.7	120.4	10.0
Total	217.7	50.8	93.3	15.3	311.0	66.1
Total						
Good 2/	1,310.7	418.5	546.9	200.2	1,857.6	618.7
Fair	1,878.7	192.5	306.3	49.1	2,185.0	241.6
Poor	3,678.5	186.7	1,012.0	55.8	4,690.5	242.5
Grand Total	6,867.9	797.7	1,865.2	305.1	8,733.1	1,102.8
Percent Distribution	78.6	72.3	21.4	22.7	100.0	100.0
Average AC/AUM	8.6		6.1		7.9	

1/ Seeded range acreage was combined with good condition grassland in Appendix IV.

2/ Includes seeded range.

Source: Appendix IV, Land and Mineral Resources. Range production has been estimated for the C-NP Study from representative situations observed and recorded in on-site surveys. Estimates are based on perennial vegetation and proper utilization.

Gully erosion in sagebrush type has resulted in range deterioration and loss of forage productivity. Such areas should be improved by brush control and revegetation for soil stability. (Bureau of Land Management)

Table 515 - Sediment Yield from Rangeland, Subregion 12, 1966

Sediment Yield 1/ Categories	Grassland	Sagebrush & Shrubs	Total	Percent
		Rangeland Acreage (1,000 Acres)		
Very Low	966.3	7,766.8	8,733.1	100
Low	--	--	--	--
Medium	--	--	--	--
High	--	--	--	--
Very High	--	--	--	--
Total	966.3	7,766.8	8,733.1	100
		Annual Sediment Yield (Acre-Feet)		
Very Low	91	728	819	100
Low	--	--	--	--
Medium	--	--	--	--
High	--	--	--	--
Very High	--	--	--	--
Total	91	728	819	100

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively.

Source: Derived from figures 73 and 74.

management practices have a significant effect on flood and sediment problems on downstream cropland and developed areas.

Measures and Practices for Watershed Protection

Rangeland measures and practices for watershed protection and improvement accomplished through 1965 are shown on table 516.

Table 516 - Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, Subregion 12, 1966

Measures & Practices	Units	Land Ownership: Public 2/	Land Ownership: Private	Total	Watershed Purposes 1/ (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grasses, shrubs)	Acres	179,900	191,700	371,600	-	x	x	-
Brush Control	Acres	78,000	220,300	298,300	-	x	x	-
Weed Control	Acres	10,200	2,800	13,000	-	x	x	-
Stream & Bank Stabilization	Acres	100	30	130	-	-	-	x
Waterspreading	Acres	1,600	19,300	20,900	-	x	x	-
Irrigation	Acres	100	30	130	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,600	400	2,000	-	x	x	x
Reducing Excessive Grazing Use	Acres	3,206,800	872,200	4,079,000	-	x	x	x
Livestock & Game Water Facilities	Number	300	800	1,100	-	x	x	-
Road Stabilization	Miles	160	NA 3/	NA 3/	x	-	x	x
Water Control Structures								
Ponds & Small Reservoirs	Number	1,100	300	1,400	-	x	x	x
	Acre Ft.	15,700	4,300	20,000	-	x	x	x
Detentions	Number	3	1	4	-	x	x	x
	Cu. Yds.	8,400	2,300	10,700	-	x	x	x
Check Dams (Gully Plugs)	Number	90	25	115	-	x	x	x
	Cu. Yds.	600	200	800	-	x	x	x
Dikes	Lin. Ft.	57,600	15,700	73,300	x	-	x	x
Diversions	Number	17	5	22	-	x	x	x
	Cu. Yds.	40,900	11,100	52,000	-	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the 4 columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4- Flood & Debris Control.
2/ Includes Federal, State, County and Municipal Ownership.
3/ Not available.
Source: Data collected from land management agencies specifically for C-NP Study.

Many of them serve management objectives other than improving the watershed. Cover improvement and soil stabilization practices have been applied on about 760,000 acres of rangeland. An estimated 371,600 acres have been revegetated, primarily by seeding poor condition sage or grass areas; brush was controlled on 298,300 acres; and 13,000 acres of weed control was reported. About half of these accomplishments were for erosion control and water conservation, and half were for improved forage production. Waterspreading of early season runoff from small drainages to deep soil areas on 20,900 acres has helped to increase cover for improved soil stability and to replenish ground waters with water that would otherwise be wasted.

Although water for livestock is normally adequate in the spring, some streams and springs dry up during late summer months. The development of about 1,100 livestock and game watering facilities

in widespread areas of the range, along with the construction of 2,000 miles of livestock fence, has helped to obtain a better distribution of range livestock use and to reduce excessive grazing on 4.1 million acres. Of significance in these adjustments has been the initiation of grazing management systems to provide sufficient rest periods for natural revegetation of range forage cover. Watershed protection measures have been incorporated in the maintenance and improvement of more than 160 miles of rangeland access roads and trails to control excessive runoff and reduce erosion.

A number of water control structures have been developed for erosion control; debris control and reduced flows; and conservation of early season runoff for subsequent livestock, recreation, and fish and wildlife use. These include 1,400 ponds and small reservoirs with a total storage capacity of 20,000 acre-feet, about 140 small detention structures and 14 miles of dikes.

Other Land

Other land, comprised of barren land, water, roads and railroads, urban areas, etc., covers about 403,700 acres, which is 4 percent of the subregion. (1) Barren land constitutes 93 percent of other land with 374,000 acres; roads and railroads 3 percent with 12,900 acres; water area 2 percent with 8,700 acres; and urban and industrial areas, farmsteads, and airports, etc., 2 percent with 8,100 acres.

Barren land, the predominant part of other land, is composed of sand dunes, playas, alkali areas, talus slopes, and lava flows. Because of the material, location, or for other reasons, water erosion is not a problem in the barren areas. The dunes and alkali areas, however, are subject to wind erosion during dry periods.

Barren areas have some beneficial use. Probably the most important is providing space. Talus slopes provide cover for wildlife, the most important of which is the chukar. Playas store flood waters for a short period of time. Some dune areas, such as those near the lost forest, provide scenic areas for vacationers.

Roads and railroads provide the routes necessary to transport livestock, grain, hay, and wood products to market and to return the products necessary for people living in the subregion. Water erosion is frequently a problem along these routes; and sediment from adjacent cropland, forest land, and range sometimes fill ditches and culverts and cover roadways.

Road damage of this type disrupts traffic and requires additional maintenance and repair crews to keep the roads serviceable. (SCS 0-1698-9)

Water that is included as part of the land, includes ponds, reservoirs, and lakes with water surfaces less than 40 acres and streams less than 1/8 mile wide. There are a number of beneficial uses for these water areas. Streams furnish over 400,000 acre-feet of water for irrigation of crops. An estimated 44 small reservoirs furnish almost 37,000 acre-feet of water for irrigation.

Small ponds are essential to the area. There are about 1,400 of these structures in the subregion, predominantly for livestock and wildlife water. However, some 20 of these have been stocked with fish and 16 are managed as fishing areas.

Of the 8,100 acres in urban, industrial, airports, and farmsteads, 4,200 acres are in urban areas. An estimated 500 acres or 12 percent of the urban areas are subject to flooding at least once in 5 years.

FUTURE NEEDS

Livestock production is expected to dominate the economy of Subregion 12, as it does at the present time. Although population is projected to increase about 53 percent by 2020, from 13,900 to 21,300, this will remain the most sparsely populated subregion, accounting for considerably less than 1 percent of the region's total. Very little shift in cover and land use is anticipated by 2020, as shown on table 517.

Table 517 - Projected Change in Cover and Land Use, Subregion 12

	1966	1980	2000	2020
	--------------1000 Acres--------------			
Cropland	365	363	361	352
Forest Land	1,893	1,874	1,842	1,805
Rangeland	8,733	8,726	8,741	8,767
Other Land	404	413	424	436
Total	11,395	11,376	11,368	11,360

Source: Soil Conservation Service, C-NPRBS Data.

Cropland

Livestock products in Subregion 12 will have to increase about 95 percent by 2020 to meet its share of the total regional needs. This will be accomplished by a more intensive use of presently used cropland with a slight decline in total acres and a small increase in irrigation. Table 518 shows the projected cropland trends.

Table 518 - Projected Trends in Dry and Irrigated Cropland Subregion 12

	1966	1980	2000	2020
	--------------1000 Acres--------------			
Cropland				
Dry Farmed	47.8	39.0	35.0	20.0
Irrigated 1/	317.2	324.0	326.0	332.0
Total	365.0	363.0	361.0	352.0

1/ Approximately 97 percent of the projections shown in Appendix IX, Irrigation.

Source: Soil Conservation Service, C-NPRBS Data.

Water Conservation

The projected increases in agricultural production will require an increase of an estimated 14,800 acres in irrigated land. In addition, water needs to be developed for those areas that do not have a full season supply, which at the present time is about 85 percent of the irrigated cropland.

The increase in irrigated cropland and supplemental water supplies will increase the demand for agricultural water supplies almost 100 percent. Table 519 shows the projected demand for the development of water supplies.

Table 519 - Projected Cumulative Trend in the Method of Irrigation, Subregion 12

Item	1966	1980	2000	2020
	(1,000 Acres)			
Sprinkler Irrigation Systems	5.6	108.3	166.3	219.1
Flood Irrigation Systems	311.6	215.7	159.7	112.9
Total	317.2	324.0	326.0	332.0

Source: Soil Conservation Service, C-NPRBS Projections.

Drainage

Presently almost 134,000 acres of cropland have a drainage problem. In addition new irrigation and supplemental irrigation are expected to increase the problem area by an estimated 13,000 acres. Almost 70 percent of this area must be drained by 2020 to meet projected food and fiber needs (table 520).

Table 520 - Cumulative Cropland Areas Needing Drainage, Subregion 12

Item	1966	1980	2000	2020
	1000 Acres			
Wet Areas	133.8	137.4	142.2	147.1
Projected Accomplishment	40.0	56.4	78.3	100.2
Remaining	93.8	81.0	63.9	46.9

Source: Soil Conservation Service, C-NPRBS Projections.

Erosion and Sedimentation

Of the 81,900 acres of cropland with an erosion potential, less than 8,000 acres currently have an erosion problem that requires correction. Since cropping patterns are expected to remain the same, that is chiefly close growing grass and legumes, the erosion problem is not expected to increase significantly (table 521).

Sedimentation is a problem on much of the eroding area. Some of this will be protected by future dams built for other purposes, predominately irrigation. This will slightly reduce the sedimentation.

Table 521 - Cumulative Cropland Areas Needing Erosion Control, Subregion 12.

Item	1966	1980	2000	2020
	----------1000 Acres----------			
Erosion Potential	81.9	86.0	91.5	97.0
Projected Accomplishments	74.1	79.5	86.7	94.0
Remaining	7.8	6.5	4.8	3.0

Source: Soil Conservation Service, C-NPRBS Projections.

Flooding

Of the 119,000 acres of cropland subject to flooding at least once in 5 years, practically all are in sod-forming crops. Since there is only minor damage to cropland from these floods, the future needs are limited to minor management adjustment, but the upper watershed area must be managed properly or flooding will become a more serious problem. However, damage to cropland, livestock, and structures have been extensive in larger floods of less frequency.

Forest Land

The forest industries of the subregion will require an estimated 30 million cubic feet of raw material per year by the year 2020. This volume will be produced on the 1.4 million acres of commercial forest land projected to remain in timber production by that time. This can be expressed as a need for 22 cubic feet per acre. Based upon the present annual industrial consumptive rate of 20 cubic feet per acre of commercial forest land, production will have to be increased by only 10 percent by the year 2020.

This can easily be accomplished through more intensive forest management practices including restocking, thinning and intermediate cuts.

The Potential Erosion Hazard Map (figure 75) and table 522 delineate the erosion hazard and sediment production potential on the forest land. This potential represents sediment yields prior to the application of protective measures and could exceed present levels by 25 times.

Table 522 - Potential Sediment Yield, without Protective Measures, Forest Land, Subregion 12

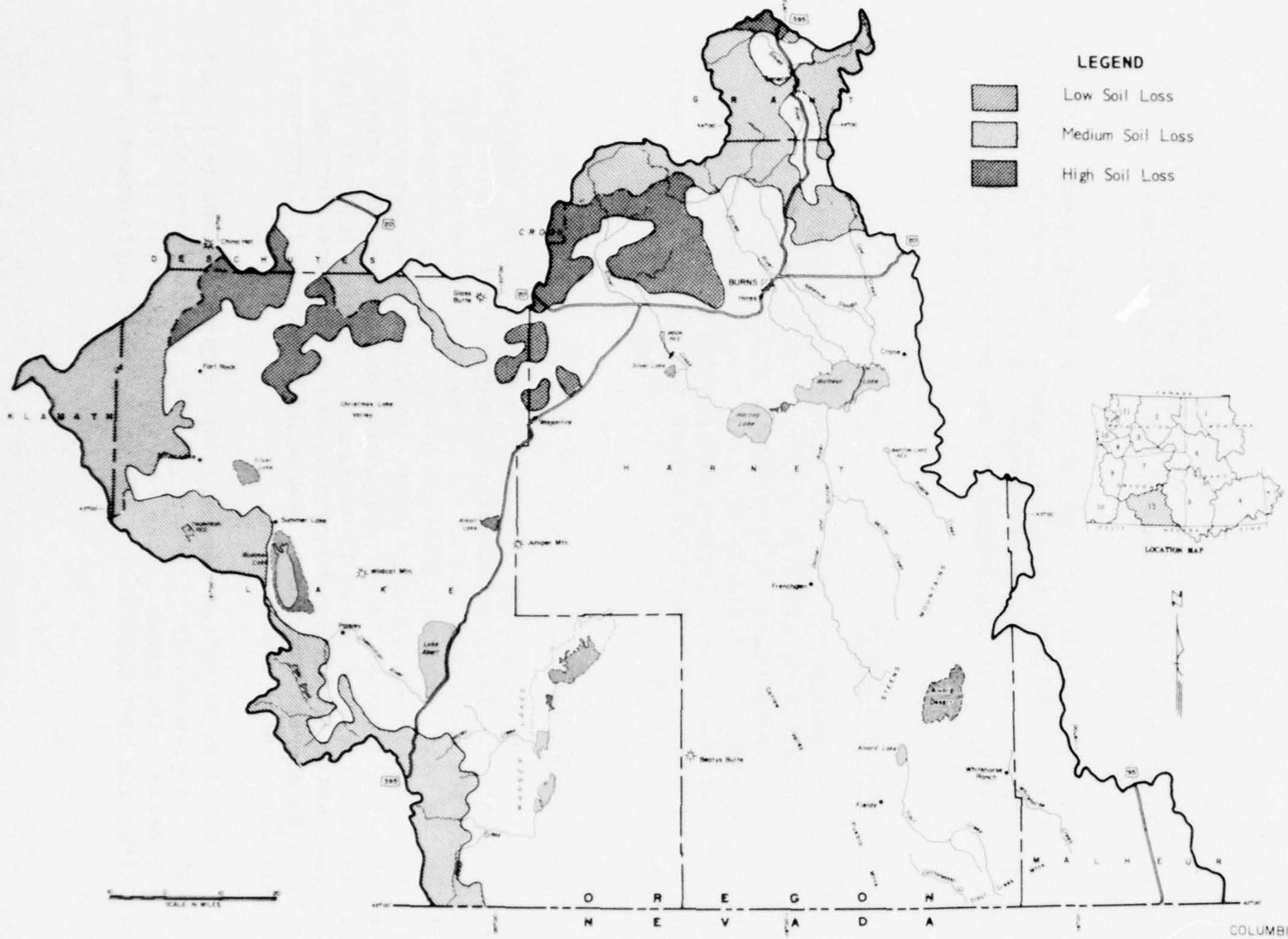
Soil Loss Category	Acres (1,000)	Percent	Acre-Feet Per Square Mile Per Year	Total Acre-Feet Per Year
Low	398.1	21	Less than 0.2	62
Medium	999.6	53	0.2 - 1.5	312
High	495.3	26	More than 1.5	1,161
Total	1,893.0	100		1,535

Source: Soil Survey Data & Interpretations, USDA Forest Service, Region 6.

About 26 percent of the forest land in the subregion would be in the "high" category, with a potential for producing over 1,100 acre-feet of sediment per year. This alone is almost 20 times the present sediment level from the forest area. Obviously, with such a potential, sufficiently high watershed protection standards and practices will need to be introduced and implemented.

Watershed Protection

In order to meet the increased timber production demands, the present annual timber harvest and road construction program will be accelerated until the ultimate road system is completed. Table 523 lists the resultant cumulative future timber harvest and road program. Also included is the estimated acreage of ground disturbed during these operations that will require watershed protection practices.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

POTENTIAL EROSION HAZARD
FOREST LAND

OREGON CLOSED BASIN
SUBREGION 12
1968

FIGURE 75

Table 523 - Projected Cumulative Timber Harvest Activity
Forest Land, Subregion 12

	Unit	1980	2000	2020
Timber Harvest Area	Ac.	239,000	556,000	873,000
Road Construction	Mi.	1,400	3,300	5,200
Ground Disturbance 1/	Ac.	50,000	116,000	183,000

1/ Includes both harvest area requiring protection and road mileage, converted to acres, requiring cut and fill treatment.
Source: Based on the 1965 level of timber requirements.

This table points out that by the year 2020, nearly 200,000 acres of forest land will have the ground cover severely disturbed by timber harvest and road construction. With over 870,000 acres under harvest by 2020, improvement in the forest protection measures is needed.

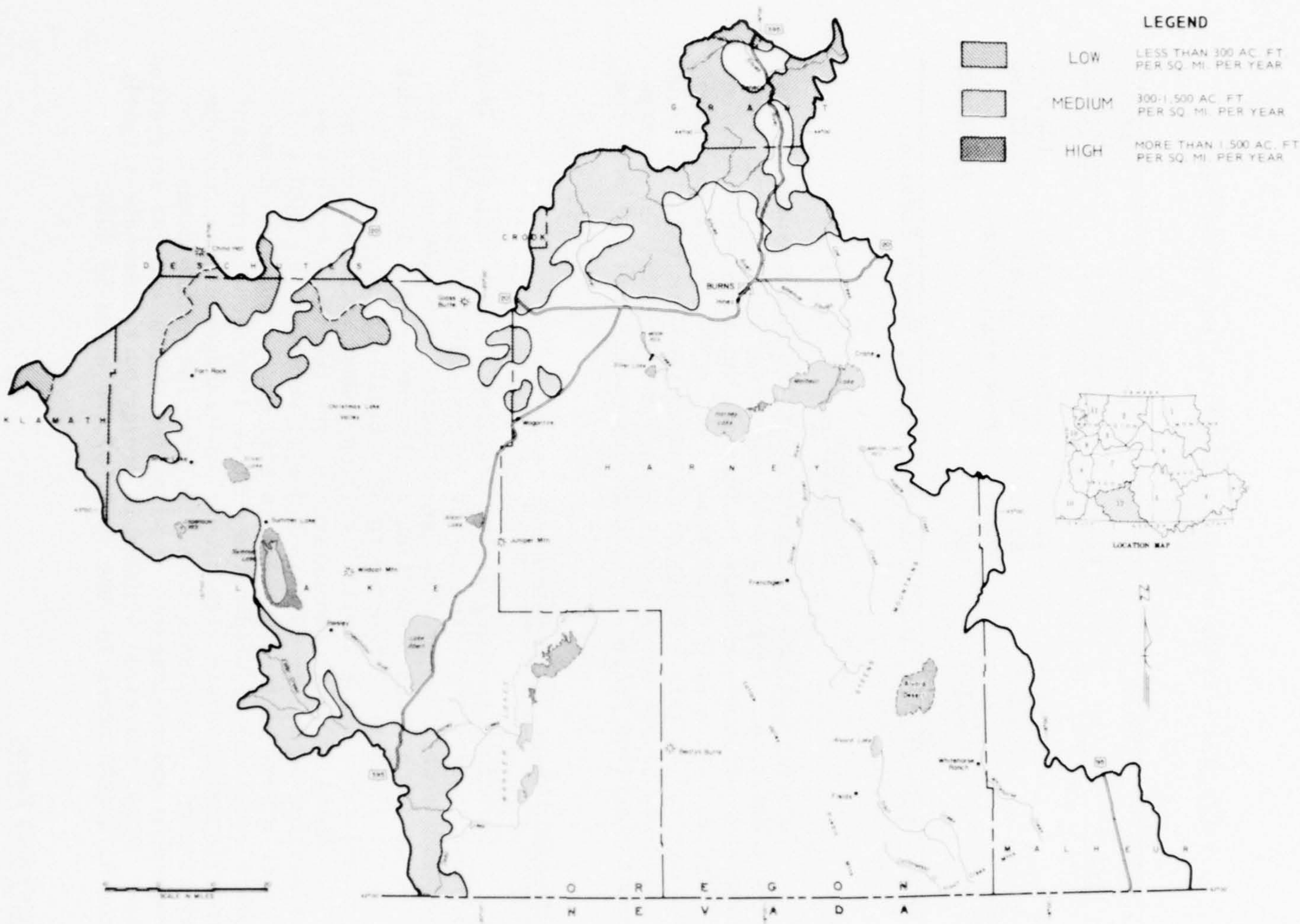
Watershed Rehabilitation

Future demands for the subregion's water supplies will require maintenance of existing quality with the pressures of heavier use. Inventories indicate about 100,000 acres need restoration work, particularly in local areas where problems now exist because of past logging and grazing practices. Rehabilitation work should be undertaken before these areas become major problems.

Water Yield Improvement

This is a water-short area with a potential for increased crop production. An improved water supply would be required. Increasing the available supply during water-short periods may well be the most important function of the forested watersheds. Presently, nearly 425,000 acre-feet, representing 43 percent of the subregion's annual runoff originates on these forest areas. This is an average of about 4" of runoff. Studies indicate that sometimes water yields can be significantly increased through designed management practices, and could be extremely important in this water-short area.

The Water Retention Capacity Map (figure 76) and table 524 indicate the ground-water storage capacity of the forest soils in the subregion. The areas in the "medium" class would be those that offer the best opportunity for water yield improvement programs.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

WATER RETENTION CAPACITY
FOREST LAND

OREGON CLOSED BASIN
SUBREGION 12
1968

FIGURE 76

Table 524 - Water Retention Capacity, Forest Soils, Subregion 12

Retention Class	Acres (1,000)	Percent	Acre-Feet per Square Mile	Total Acre-Feet
Low	227.1	12	Less than 300	106,000
Medium	1,665.9	88	300 - 1,500	2,343,000
High	--	--	More than 1,500	--
Total	1,893.0	100		2,449,000

Source: Soil Survey Data & Interpretations, Forest Service, Region 6.

Rangeland

Future rangeland watershed needs include measures to resolve present watershed problems and to adequately protect range resources throughout projected changes in land and resource use. Erosion and sedimentation is a significant problem on 1.8 million acres of rangeland in this subregion; flooding problems exist on 64,600 acres; some 52,800 acres have drainage problems.1/ The average annual rangeland sediment yield is presently about 819 acre-feet.

Projected Use of Range Resources

Livestock ranching is the dominant economic activity in this area and livestock grazing is the largest single use of lands. Rangeland forage now produces an estimated 36.5 precent of the total beef and sheep production of the subregion. In 1964, beef and veal production amounted to 58.6 million pounds. This is expected to increase to 114.0 million pounds or 95 percent by 2020. Sheep and lamb production is expected to increase from 1.8 million pounds in 1964 to 2.4 million pounds in 2020.(3) To meet a part of the increase in livestock production needs, future range forage production must be increased to the extent possible commensurate with proper land management and resource utilization. Rangelands must also meet increasing demands for production and enhancement of wildlife habitat and for recreation uses. Total rangeland acreage is projected to increase slightly from 8,733,000 acres in 1966 to 8,767,000 acres by 2020.

Watershed Needs

An estimated 494,000 acres of rangeland had received land treatment by 1966 for erosion and sedimentation control with

1/ Soil Conservation Service, C-NPRBS data.

accompanying flood control and drainage benefits. This included most of the measures and practices for cover improvement and soil stabilization given the "Present Status" section, along with accomplishments in road stabilization. Where multiple practices were involved, overlapping acreage was deleted. An additional 358,000 acres will require treatment by 1980, 714,000 acres by 2000, and 1.0 million acres by 2020. Land treatment for cover improvement and soil stabilization should be supplemented by construction of a number of small water control structures, such as detention dams, check dams (gully plugs), and diversion dams, for erosion and sediment control.

Protection and management practices have been implemented on some 4.1 million acres of rangeland to improve watershed conditions and afford better long-term resource use. Excessive livestock grazing use has been reduced or adjusted to the grazing capacity of the range, and special fire control practices have been initiated where required. Improved livestock distribution and control required development of livestock and game water facilities and construction of livestock control fences. These protection and management practices should be intensified and extended to an additional 599,000 acres by 1980, 605,000 acres by 2000, and 610,000 acres by 2020. Whenever possible and practicable, improved and more intensive management practices for watershed rehabilitation and protection are preferable to more costly construction measures which also cause greater disturbance to the environment and wildlife habitat. More information is needed on the relative importance of big game and domestic livestock and their competing use of range forage. Special areas need to be set aside and developed as a source of winter feed for big game.

In the future, a number of streams and waterways in range areas will require stream clearance, channel improvement, and efforts to improve water quality. Some 14 miles need attention by 1980, 69 miles by 2000, and 139 miles by 2020. More consideration must be given to water quality standards and control relative to rangeland use and management. Deficient water quality areas must be identified and specific measures and practices determined to achieve the objectives of improved water quality.

An estimated 3 miles of bank stabilization work had been accomplished in rangeland areas by 1966. This included the stream and bank stabilization acreages reported in the "Present Status" section with conversion to miles on the basis of 40 acres per mile. Future needs include an additional 85 miles along streams or reservoirs by 1980, 240 miles by 2000, and 430 miles by 2020.

About 14 miles of dikes have been constructed on rangelands to provide flood control and prevent damage from sediment and debris. An additional 2 miles of dikes will be needed by 1980, 11 miles by 2000, and 22 miles by 2020.

Other Land

The population in the Oregon Closed Basin is expected to increase by over 50 percent or 7,400 people by the year 2020. This increase in population will require a shift in land use to meet the need for urban growth, industrial developments, and new roads. The shift to other land is expected to increase by 31,800 acres by 2020. This projected shift will come from cropland, forest land, and rangeland to other land. The present urban areas need protective measures for over 500 acres that are subject to flooding at a frequency of once in 5 to 10 years.

Other land in this subregion is 80 percent barren. Most of this is rock with some sand dunes and alkali flats. Very little can be done toward making these areas productive.

MEANS TO SATISFY NEEDS

The land measures and watershed protection needs for Subregion 12 are translated in this section into definite structural and nonstructural programs designed to improve the watershed condition. When these needs are satisfied, many of the existing watershed problems that presently result in damage and economic loss will be modified or solved. The means to accomplish watershed protection and proper management are discussed and evaluated in terms of individual items which are costed in 1969 dollars.

The primary watershed problem for large portions of the subregion is that soils require protection and stabilization. Low total annual precipitation is the basic reason for this problem. Because of this lack of water, vegetation is often sparse affording little or no protection during infrequent periods of excessive runoff.

Great potential exists for conservation of excessive runoff water in reservoirs for flood protection and subsequent use for irrigation, stockwater, industry, domestic, recreation, pollution abatement, and fish and wildlife. Estimates indicate the need for the development of both large and small reservoirs. During the next 50 years, the requirement for storage in ponds and small reservoirs is an additional 78,000 acre-feet. Within the Malheur Basin, 23 medium size reservoirs with a total storage capacity of 611,000 acre-feet have been identified. In the western portion of the subregion, six possible reservoir sites with a potential storage capacity in excess of 94,000 acre-feet have been listed.

The Soil Conservation Service has made a survey of the Conservation Needs Inventory, which was extended and expanded by the river basin staff. The subregion was divided into 61 watershed areas to facilitate the study. Of the subregion's 61 watersheds, 16 have a need for cooperative development under various Federal and State programs. Table 525 shows the needs of these watersheds and figure 77 shows their general location.

Table 525 - Practices Required for Cooperative Conservation Development, Subregion 12

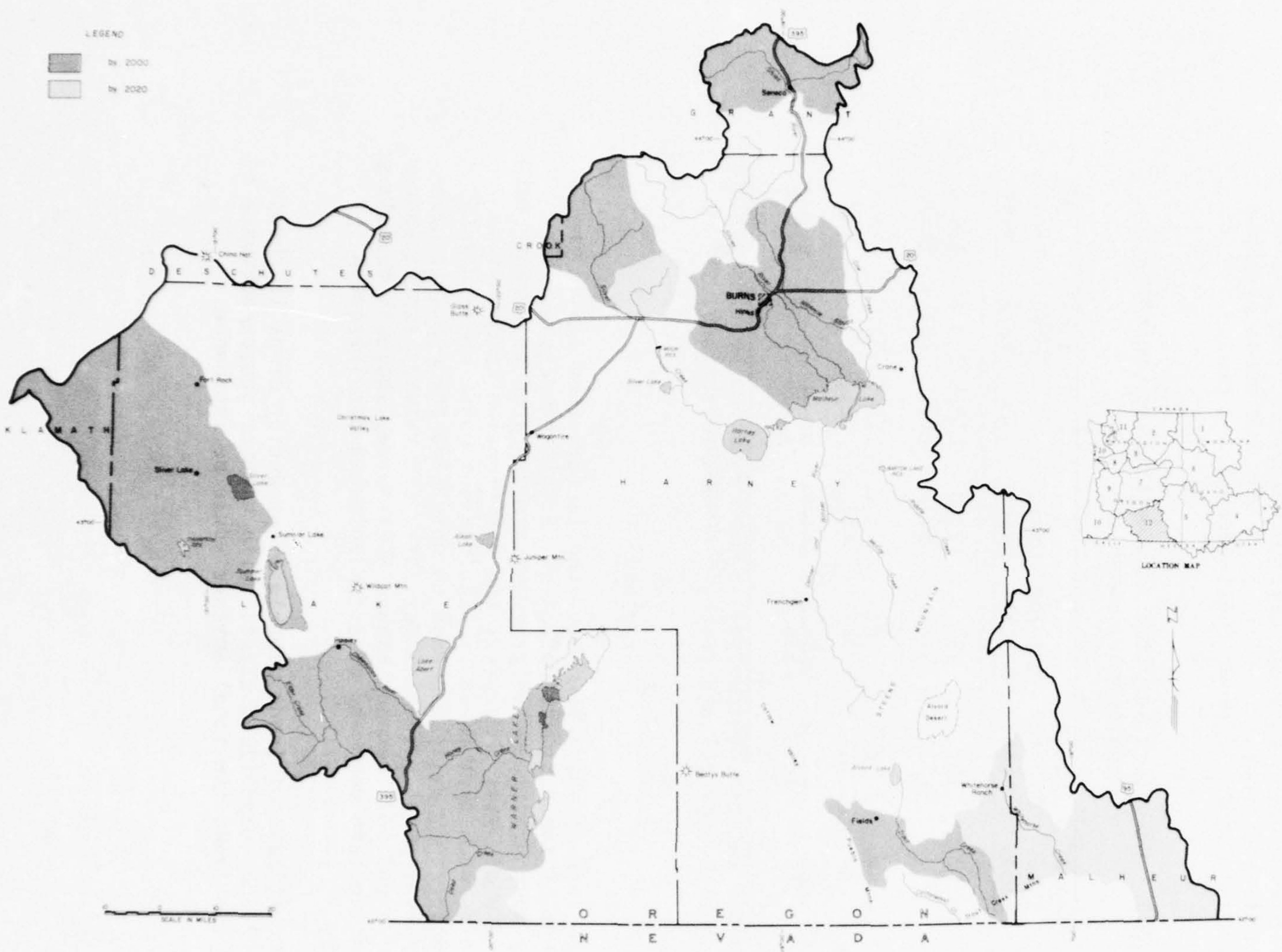
Target Date	No. of Watersheds	Flood Protection	Erosion Control	Drainage	Irrigation New	Irrigation Potential	Land Treatment
		1000 Acres					
2000	12	128.4	327.9	121.9	133.5	203.8	465.3
No. Watersheds 1/		(12)	(12)	(12)	(12)	(12)	(12)
2020	4	4.5	8.5	4.2	17.3	32.3	13.3
No. Watersheds 1/		(3)	(4)	(4)	(2)	(4)	(4)
Total	16	132.9	336.4	126.1	150.8	236.1	478.6

1/ Number of watersheds involved in each function by time periods.
Source: Soil Conservation Service, C-NPRBS Projections.

Cropland

The lack of water is one of the factors that limits the development of the ultimate potential of this subregion. Consequently most practices and programs are designed to improve the availability of water. However, the distribution in both time and place is such that there is insufficient water where needed. Considerable study will be needed to determine the specific areas having a development potential for water and related land resource. Estimates based on a reconnaissance soil survey indicate that large tracts of land are composed of soils suitable for irrigated cropland.

An estimate of lands capable of producing crops is shown in table 526 by capability class. With a water source adequate to irrigate the land, the total acreage would be increased.



COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

AREAS NEEDING COOPERATIVE WATERSHED DEVELOPMENT

OREGON CLOSED BASIN
SUBREGION 12

1968

FIGURE 77

Table 526 - Land Areas Suitable for Crop Production
Subregion 12, 1966

Capability Class 1/	Total (1000 Acres)	Percent
I	--	
II	94.5	8
III	510.0	44
IV	545.0	48
Total	1,149.5	100

1/ Appendix IV, Land and Mineral Resources.
Source: Soil Conservation Service, C-NPRBS Data.

Sprinkler irrigation reduces transmission losses, improves the efficiency of application, reduces labor cost, and reduces erosion. (SCS F-456-1)

Water Conservation

Currently the most acute water conservation problem is that 85 percent of the 317,000 acres presently irrigated are short of water. The amount of water necessary to provide full coverage is

estimated to be over 800,000 acre-feet. In addition, water is available in the subregion to irrigate only a small portion of the potentially irrigable soils. Storage reservoirs, coupled with improved irrigation efficiencies, could improve the situation in both cases, since almost 90 percent of the water diversion is from streamflow.

The irrigated area is projected to increase about 17,200 acres by 2020 with diversion increasing over 455,000 acre-feet. To realize this, very careful management of water will be required, since this is about 50 percent of the estimated average annual yield for the subregion.

At the present time, irrigation water is obtained from streamflow, ground water, and reservoirs with streams furnishing just under 90 percent of the water. Table 527 shows the probable trends in water development for on-the-farm needs.

Table 527 - Present and Future Sources of Irrigation Water
Subregion 12

Item	1966	1980	2000	2020
	1000 acre-feet			
Projected Farm Delivery	463.9	588.2	753.9	919.6
Possible Source				
Stream	406.4	341.4	308.9	276.4
Ground	20.9	77.2	153.4	265.4
Reservoir	36.6	169.6	291.6	377.8

Source: Soil Conservation Service, C-NPRBS Projections.

One way to increase irrigation efficiencies is to change from flooding to sprinkler irrigation on high intake soils. Most of the irrigated soils have intake rates of above 2 inches per hour, and a number of these have rates above 4½ inches per hour. Table 519 (Needs section) shows the necessary change in irrigation methods in order to meet the demand for improved efficiencies.

Adapted grasses and alfalfa are expected to continue as the major crops for the next 50 years. High value crops such as sugar beets, potatoes, and vegetables are not projected to become important. Since irrigation is but one of many alternative investment opportunities, efficient allocation of resources will result only when the investments are comparable with returns from other possible investments. Inputs such as fertilizer, improved pasture, and drainage are some of the possible alternative investments.

Opportunities for improving efficiency through combining irrigation distribution works and transferring water rights to the more productive soils are some other possibilities that could be investigated.

A number of irrigation systems need to be improved to meet the water conservation needs in the subregion. This includes the following: Land leveling and shaping for better water management of the flatter slopes with soils suitable for flood irrigation; sprinkler systems on the areas with steeper slopes and with the coarser-textured soils; ditch lining and pipe lines to reduce loss of water in conveyance and distribution systems; and increased information on waterholding capacities and intake rates of the irrigable soils. Table 528 shows some of the practices needed to provide for the efficient use of irrigation water.

Table 528 - Cumulative Projected Practices for Irrigated Cropland, Subregion 12

Practice	Unit	1966	1980	2000	2020
Water Control Facilities	No.	3,480	4,090	4,710	5,930
Irrigation Water Conveyance	Mi.	1,560	1,840	2,110	2,660
Water Storage Facilities	No.	44	52	60	75
Irrigation System, Surface	No.	7,800	6,700	5,300	3,900
Irrigation System, Sprinkler	No.	127	2,370	4,930	8,750
Land Shaping	1000 Acs.	41	49	56	70
Irrigation Water Mgt.	1000 Acs.	16	85	177	270

Source: Soil Conservation Service, C-NPRBS Projections.

Existing irrigation developments have generally been individual efforts, although some systems have been developed by small groups. Where surface water is to be used for irrigation, future developments will require larger groups and projects.

Additional and enlarged reservoirs for storage of spring floodflows are needed to reduce damage from flooding and to make more beneficial use of the limited water supply in the basin. Improved irrigation water management is essential if maximum yields are to be realized with existing water supplies. On some soils this could mean increased use of sprinkler systems.

Studies indicate that ground water could be developed to a much greater extent in some areas. Presently, the most extensive use of ground water for irrigation is in the Alvord and

Harney Valleys. Data on existing wells in the Alvord area indicate that sufficient quantities of good quality ground water exist within economic pumping lifts to irrigate an additional 28,000 acres. The Catlow Valley also has a potential ground-water source according to available geologic and well data. In the Silvies River and Donner and Blitzen River basins many irrigation wells are used to supplement water supplies during low streamflow periods. Additional studies are needed throughout the subregion to determine the ultimate potential supply of the ground-water basins. These studies should show the recharge capabilities as well as the safe yield rate.

Proposed water management methods include artificial recharge and combined use of ground water and surface water to allow more effective use of total water supply. Lowering of ground water by draining waterlogged land to salvage water now lost to evaporation can also increase the total available water. The benefits that can be derived from management of the ground-water reservoirs in this area are potentially large. Full and effective management has been hampered by lack of adequate information on the complex pattern of ground-water recharge and flow and by conflicts with established water rights.

The sparse and scattered population makes the development of efficient project type distribution systems difficult. The average cropland area per ranch is just over 900 acres, with only about 400 ranching units in the subregion. Present Federal policy places a very low priority on projects with a limited number of benefiting participants.

Drainage

In the subregion, 134,000 acres are estimated to have a wetness problem. Of these, 3,000 acres have a slight problem, 102,000 acres have a moderate problem, and 29,000 acres have a severe problem. Table 520 (Needs section) shows the cropland area with a potential drainage problem and the area remaining to be treated. The small increase in the problem area is attributed to an increase in irrigation.

The level of drainage improvement required to meet the needs of this subregion will not be high when compared to other subregions. The primary cropland use is for hay and pasture, allowing selection of species of grasses and legumes which are more tolerant to excess water and which will satisfy forage crop needs.

Surface and subsurface water disposal systems are essential in wet areas if cropland is to be seeded at the proper time and crops are to survive. Drainage also increases yields and reduces the cost of harvesting. (SCS 0-435-5)

Needs for improved drainage will be met by: Improved surface drainage to permit farming operations earlier in the season; open drain ditches to lower the water table; improved and additional outlets; construction of sumps and pumping plants; and tile drains to lower the water table, as well as to intercept seepage waters from higher lands. An estimated 94,000 acres of excessively wet arable soils in the basin require one or more of these needs. Drainage improvement on about 50 percent of this area will also require flood protection and irrigation water management. Table 529 shows drainage practices that will be needed to satisfy the cropland drainage needs at the projected rate.

Table 529 - Cumulative Drainage Practices Required to Provide Needed Drainage, Subregion 12

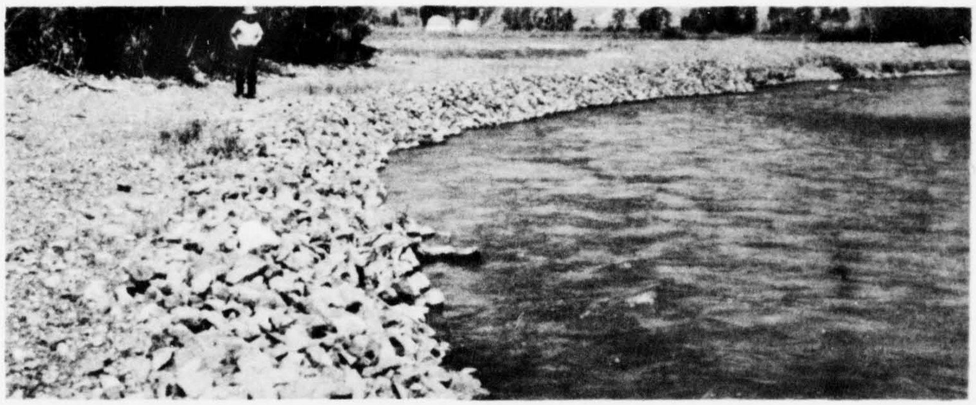
Practice	Unit	1966	1980	2000	2020
Conduits & Ditches	Miles	243	343	474	608
Structures	No.	2	6	10	14

Source: Soil Conservation Service, C-NPRBS Projections.

Erosion and Sedimentation

The erosion potential in cropland areas and the remaining areas that will be treated are shown in table 521. Of the 81,900

acres of cropland with an erosion and sedimentation potential, less than 8,000 acres have an existing problem. The erosion potential will gradually increase to 97,000 acres by 2020, because of a shift in cropland areas to more erodible soil. The area to be treated will decrease from 8,000 acres to 3,000 acres as cropland use shifts from grain to forage crops and prescribed erosion control practices are accomplished (table 530).



Stream channel diking and revetment prevent stream bank erosion and over bank flooding. (SCS F-137-17)

Table 530 - Cumulative Practices to Satisfy Erosion Control Needs, Subregion 12

Practice	Unit	1966	1980	2000	2020
Grade Stabilization Structures	No.	184	197	215	234
Diversions	Mi.	50	54	59	64
Ditch Bank Seeding	Mi.	8	9	10	11
Field Windbreaks	Mi.	2	3	4	5
Crop Residue Use	1000 Acs.	32	34	37	41
Stubble Mulch	1000 Acs.	6	7	8	8
Stripcropping	1000 Acs.	6	7	7	8
Conservation Cropping System	1000 Acs.	38	41	44	48
Pasture & Hayland Planting	1000 Acs.	24	26	28	30

Source: Soil Conservation Service, C-NPRBS Projections.

Flooding

Flood protection is needed in several areas in the subregion, but the most critical are the lower reaches of the Silvies and the Chewaucan Rivers. Upstream storage together with channel improvement would alleviate flooding. Table 531 shows the projected stream channel and diking measures considered necessary to prevent local flooding.

Table 531 - Cumulative Cropland Flood Protection Practices, Subregion 12

Practice	1966	1980	2000	2020
		(Miles)		
Stream Channel Improvement	53	153	286	420
Dikes & Levees	51	143	266	390
Streambank Protection	26	52	87	120
Stream Channel Stabilization	1	4	8	13

Source: Soil Conservation Service, C-NPRBS Projections.

Program Cost

The cost of implementing conservation practices discussed in the previous sections are scheduled in table 532.

Table 532 - Estimated Cost of Cropland Conservation Practices, Subregion 12

Item	Water Conservation	Drainage	Erosion Control	Flood Prevention	Total
	1000 Dollars				
1966-1980					
Private Funds	169,414	756	3,474	6,697	180,341
Public Funds	45,206	552	613	14,231	60,602
Technical 1/	4,004	210	140	35	4,389
Total	218,624	1,518	4,227	20,963	245,332
1981-2000					
Private Funds	312,090	2,532	5,369	19,788	339,779
Public Funds	73,070	1,104	947	42,050	117,171
Technical 1/	8,610	420	210	100	9,340
Total	393,770	4,056	6,526	61,938	466,290
2001-2020					
Private Funds	408,250	3,356	5,837	31,495	448,938
Public Funds	86,180	1,464	1,030	66,926	155,600
Technical 1/	12,460	550	230	150	13,390
Total	506,890	5,370	7,097	98,571	617,928

1/ Includes public and private costs.
Source: Soil Conservation Service, C-NPRBS Projections.

Forest Land

Increasing demands for lumber, plywood and other forest products will cause increasing pressures on the forest lands of the subregion. Likewise, livestock production needs will also put additional pressures on these forested areas. These demands can be met without damage only by assuring continued high levels of watershed protection, more intensive management practices, and improved streamflows through vegetation manipulation and snowfield management. These measures go hand in hand with the structures and other projects designed to develop the water potential of an area.

Watershed Protection

It is anticipated that the intensity of watershed protection conducted concurrently with logging and road construction, as outlined in table 512, will accelerate or at least continue at present levels on the public forest lands. A level equivalent

to that presently on public lands will be necessary for the private areas by 2020, especially on sites with a high erosion or sediment yield potential. Table 533 outlines the anticipated total cost of such measures, accumulated through the year 2020. These costs are based on the assumption that: (1) On the public forest lands, controls through timber sale and construction contracts are adequate if properly applied; and (2) on the private forest lands, the minimum required by year 2020 will be about equal to that presently done on the public lands.

At this rate, recurrent watershed protection measures will cost about $660,000 annually on the public forest lands and should cost $190,000 annually on the private. Converting the annual costs to totals, this amounts to $46,965,000. This represents the cost of maintaining the productive condition of the forest watersheds under the pressure of the projected demands.

Table 533 - Projected Costs for Watershed Protection Practices
Forest Land, Subregion 12

Practices	Unit	Total Units 1/	Total Cost 1/ $1000
PUBLIC FOREST LAND			
Logging Disturbance Treatment	Ac.	96,000	1,920
Harvest Road Treatment 2/	Mi.	3,800	950
Other Watershed Requirements 3/	Ac.	1,526,000	33,680
Total Cost			36,550
PRIVATE FOREST LAND			
Logging Disturbance Treatment	Ac.	35,000	525
Harvest Road Treatment	Mi.	1,400	280
Other Watershed Requirements	Ac.	251,000	9,610
Total Cost			10,415
TOTAL ALL LAND			
Logging Disturbance Treatment	Ac.	131,000	2,445
Harvest Road Treatment	Mi.	5,200	1,230
Other Watershed Requirements	Ac.	1,777,000	43,290
Total Cost			46,965

1/ Total for 55 year period 1965-2020. Costs in 1969 dollars.
2/ Includes road maintenance.
3/ Includes watershed surveys, plans, fire protection, special road requirements, timber, cultural practices and other indirectly related items.

Watershed Rehabilitation

The forest land acreage presently requiring treatment and the amount that should be accomplished during time periods 1980, 2000, and 2020 are listed in table 534. Table 535 outlines the expected sediment reduction through the application of these measures.

Table 534 - Projected Watershed Rehabilitation Programs, Forest Land, Subregion 12

Program	Unit	1980 Amount	1980 Cost 1/ $1000	2000 Amount	2000 Cost 1/ $1000	2020 Amount	2020 Cost 1/ $1000
FEDERAL LANDS							
Land Treatment	Ac.	5,000	500	10,000	1,000	10,000	1,000
Stream Rehabilitation	Mi.	80	1,640	45	923	--	--
Road Rehabilitation	Mi.	155	61	--	--	--	--
Total Cost			2,201		1,923		1,000
NONFEDERAL LANDS							
Land Treatment 2/	Ac.	10,000	150	20,000	300	20,000	300
Stream Rehabilitation	Mi.	5	3	5	3	5	3
Road Rehabilitation	Mi.	10	1	10	1	10	1
Total Cost			154		304		304
TOTAL ALL LANDS							
Land Treatment	Ac.	15,000	650	30,000	1,300	30,000	1,300
Stream Rehabilitation	Mi.	85	1,643	50	926	5	3
Road Rehabilitation	Mi.	165	62	10	1	10	1
Total Cost			2,355		2,227		1,304

1/ In 1969 dollars.
2/ SCS River Basin Survey Data.

The overall expected sediment reduction is 2.4 acre-feet per year. Although a low amount, past forest land use activities have resulted in extremely low sediment yields, therefore, requiring lesser amounts of rehabilitation work.

In addition to the needs for sediment reduction on the presently eroding forest lands, nonrecurrent work will be required on any future extensive or large forest burns and lands directly related to future water storage projects. These sediment sources will be treated as they occur, when and if treatment is needed. Hence the 4 percent overall sediment reduction is that amount possible should no new sources occur through catastrophic fire or other natural disasters.

Table 535 - Expected Annual Sediment Reduction
Forest Land Rehabilitation, Subregion 12

Present Yields 1/	Acres (1000)	Total Sed. Yield Ac.Ft./Yr.	Acres Treated 2/	Sediment Reduction Ac.Ft./Yr.
Very low	1,893.0	59	100,000	2.4
Low	--	--	--	--
Medium	--	--	--	--
High	--	--	--	--
Very high	--	--	--	--
Total	1,893.0	59	100,000	2.4

Total reduction percent 4

1/ Data from table 511.
2/ Data from table 534. Miles treated converted to acres.

Water Yield Improvement

Manipulation of the forest cover may have the greatest single effect on increasing runoff volumes in the subregion. Timber cutting practices, and changes in timber types hold promise. Snowpack management, prolonging snowmelt and reducing the soil moisture deficit through water spreading are other measures planned for the subregion.

The projected water yield improvement programs needed and the amount that should be accomplished during time periods 1980, 2000, and 2020 are listed in table 536. Timber cover on the private forest lands is adjusted principally to meet logging requirements. Therefore, water yield improvement practices and benefits are not estimated, although some benefit does occur.

Table 536 - Projected Water Yield Improvement Practices, Public Forest Land, Subregion 12

Program	Unit	1980 Amount	1980 Cost 1/ $1000	2000 Amount	2000 Cost 1/ $1000	2020 Amount	2020 Cost 1/ $1000
Cover Manipulation 2/	Ac.	20	2	20	2	20	2
Snowpack Management	Mi.	5	250	5	250	5	250
Water Spreading 3/	Ac.	1,200	472	1,600	629	1,500	590
Total Cost			724		881		842

1/ In 1969 dollars.
2/ Includes type conversion and riparian vegetation management.
3/ Planned for altering timing of runoff or ground water recharge, not for irrigation or other resource activity.

Total Program Costs

In summary, the total cost of forest watershed protection and land treatment programs through the year 2020 may be expressed as follows:

	Cost ($1,000)
Watershed Protection	46,965
Watershed Rehabilitation	5,886
Water Yield Improvement	2,447
	55,298

Rangeland

Measures and Practices for Watershed Protection

Requirements to satisfy future needs for rangeland watershed protection, rehabilitation, and improvement in Subregion 12 are shown on tables 537, 538, and 539. Most of these practices which improve watershed conditions also have other management objectives or purposes. Cover improvement and soil stabilization practices will be required on a combined total of about 1.5 million acres of rangeland. To provide more ground cover, a new area of about 420,000 acres should be seeded and another 260,000 acres should be reseeded. On deteriorated range areas with sedimentation and erosion problems, trees or shrubs may be established on about 19,000 acres where there is sufficient moisture. About 70 percent

Table 537 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1966 to 1980, Subregion 12

Measures and Practices	Units	Land Ownership: Public 2/	Private	Total	Watershed Purposes 1/: (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	239,000	65,000	304,000	-	x	x	x
Brush Control	Acres	141,500	38,500	180,000	-	-	x	x
Weed Control	Acres	3,900	1,100	5,000	-	-	x	-
Conversion of tree cover to grass	Acres	2,200	600	2,800	-	-	x	x
Contouring, Pitting, Furrowing	Acres	10,400	2,800	13,200	-	x	x	x
Deep Tillage	Acres	1,600	400	2,000	x	x	x	-
Stream & Bank Stabilization	Acres	2,700	700	3,400	-	x	x	x
Waterspreading	Acres	1,100	300	1,400	-	x	x	x
Irrigation	Acres	150	50	200	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	1,400	400	1,800	-	x	x	x
Reducing Excessive Grazing Use	Acres	470,500	128,000	598,500	-	x	x	-
Livestock & Game Water Facilities	Number	1,300	300	1,600	-	x	x	x
Special Fire Control	Acres	3,700	1,000	4,700	-	x	x	x
Road Stabilization								
Existing Roads	Miles	130	30	160	x	-	x	x
New Roads	Miles	80	20	100	-	-	x	x
Pollution Abatement	Miles	11	3	14	-	-	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	1,800	500	2,300	-	x	x	x
	Acre Ft.	27,400	7,500	34,900	-	x	x	x
Detentions	Number	4	1	5	-	x	x	x
	Cu. Yds.	10,900	3,000	13,900	-	x	x	x
Check Dams (Gully Plugs)	Number	1,400	400	1,800	-	x	x	x
	Cu. Yds.	275,900	75,000	350,900	-	x	x	x
Dikes	Lin. Ft.	8,700	2,400	11,100	-	x	x	x
Diversions	Number	23	6	29	-	x	x	x
	Cu. Yds.	155,200	42,200	197,400	-	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Table 538 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 1981 to 2000, Subregion 12

Measures and Practices	Units	Land Ownership: Public 2/	Private	Total	Watershed Purposes 1/: (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	170,700	46,500	217,200	-	x	x	x
Brush Control	Acres	179,000	48,700	227,700	-	x	x	x
Weed Control	Acres	6,200	1,700	7,900	-	x	x	-
Fertilizing	Acres	12,000	3,300	15,300	-	x	x	x
Conversion of tree cover to grass	Acres	2,200	600	2,800	-	x	x	x
Contouring, Pitting, Furrowing	Acres	24,000	6,500	30,500	-	x	x	x
Deep Tillage	Acres	1,600	500	2,100	x	x	-	-
Stream & Bank Stabilization	Acres	4,900	1,300	6,200	-	x	x	x
Waterspreading	Acres	2,200	600	2,800	-	x	x	x
Irrigation	Acres	200	60	260	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	2,400	700	3,100	-	x	x	-
Livestock & Game Water Facilities	Number	1,000	300	1,300	-	x	x	x
Special Fire Control	Acres	5,000	1,300	6,300	-	x	x	x
Road Stabilization								
Existing Roads	Miles	130	30	160	x	-	x	x
New Roads	Miles	65	20	85	-	-	x	x
Pollution Abatement	Miles	45	10	55	-	x	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	2,100	600	2,700	-	x	x	x
	Acre Ft.	20,800	5,700	26,500	-	x	x	x
Detentions	Number	3	1	4	-	x	x	x
	Cu. Yds.	8,700	2,400	11,100	-	x	x	x
Check Dams (Gully Plugs)	Number	800	200	1,000	-	x	x	x
	Cu. Yds.	68,100	18,500	86,600	-	x	x	x
Dikes	Lin. Ft.	38,300	10,400	48,700	-	x	x	x
Diversions	Number	27	7	34	-	x	x	x
	Cu. Yds.	40,300	11,000	51,300	-	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4- Flood & Debris Control.
2/ Includes Federal, State, County and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Table 539 - Required Rangeland Measures and Practices for Watershed Protection and Other Management Purposes, 2001 to 2020, Subregion 12

Measures & Practices	Units	Land Ownership: Public 2/	Private	Total	Watershed Purposes 1/: (1)	(2)	(3)	(4)
Cover Improvement & Soil Stabilization								
Revegetation (grass, shrubs)	Acres	140,100	38,100	178,200	-	x	x	x
Brush Control	Acres	185,300	50,400	235,700	-	x	x	x
Weed Control	Acres	5,300	1,500	6,800	-	x	x	-
Fertilizing	Acres	12,000	3,300	15,300	-	x	x	x
Conversion of tree cover to grass	Acres	3,300	900	4,200	-	x	x	x
Contouring, Pitting, Furrowing	Acres	25,600	7,000	32,600	-	x	x	x
Deep Tillage	Acres	1,600	400	2,000	x	-	-	-
Stream & Bank Stabilization	Acres	6,000	1,600	7,600	-	x	x	x
Waterspreading	Acres	2,700	700	3,400	-	x	x	x
Irrigation	Acres	500	200	700	-	x	-	-
Watershed Oriented Land Management Practices								
Livestock Control Fences	Miles	2,100	600	2,700	-	x	x	x
Livestock & Game Water Facilities	Number	400	100	500	-	x	x	x
Special Fire Control	Acres	4,300	1,200	5,500	-	x	x	x
Road Stabilization								
Existing Roads	Miles	130	30	160	-	-	x	x
New Roads	Miles	16	4	20	-	-	x	x
Pollution Abatement	Miles	55	15	70	-	x	x	-
Water Control Structures								
Ponds & Small Reservoirs	Number	2,100	600	2,700	-	x	x	x
	Acre Ft.	12,800	3,500	16,300	-	x	x	x
Detentions	Number	3	1	4	-	x	x	x
	Cu. Yds.	10,900	3,000	13,900	-	x	x	x
Check Dams (Gully Plugs)	Number	900	300	1,200	-	-	x	x
	Cu. Yds.	67,100	18,200	85,300	-	-	x	x
Dikes	Lin. Ft.	44,100	12,000	56,100	x	x	x	x
Diversions	Number	11	3	14	-	x	x	x
	Cu. Yds.	44,200	12,000	56,200	-	x	x	x

1/ Most measures and practices have joint benefits or purposes. Watershed purposes of listed measures and practices are indicated in the four columns as follows: Col. 1-Drainage; Col. 2-Water Conservation; Col. 3-Erosion & Water Quality Control; Col. 4-Flood & Debris Control.
2/ Includes Federal, State, County and Municipal Ownership.
Source: Data collected from land management agencies specifically for the C-NP Study.

Range areas are plowed to kill undesirable species that do not give adequate ground cover. This practice prepares a seedbed for vegetation which is more useful, protective, and erosion resistant. (Bureau of Land Management)

of the revegetation requirements will be for improved watershed conditions, and 30 percent for other management objectives. Other significant practices include some 643,000 acres of brush control for replacement with more useful, protective, and erosion resistant vegetation, and an estimated 17,200 acres (approximately 400 miles) of bank stabilization along streams or above reservoirs.

Soil and watershed surveys, which presently cover about 4.0 million acres, should be extended to an additional 4.4 million acres by 2020. More intensive secondary surveys will be required on many areas to update previous work and to measure managment results. Watershed plans by 2020 should embrace approximately 6.2 million acres with continual adjustments.

About 7,600 miles of livestock fencing should be constructed for protection of conservation works, rehabilitation of eroded or deteriorated lands, and control of livestock use in areas of primary value for fish and wildlife, and grazing system management. An additional 3,400 livestock and game water facilities are needed for broader and more uniform distribution of livestock, conservation of existing water supplies, and preservation of the quality of water. On most rangelands, livestock use has been adjusted to the current grazing capacity. Continual adjustment is necessary to assure proper range use and some reduction is still necessary on about 600,000 acres, mostly private lands. Special fire control efforts are required on about 16,500 acres mainly to provide ample water storage for fire emergencies. About 480 miles of existing roads and 200 miles of new roads need ditches and culverts to control runoff and other protective practices to reduce erosion and sedimentation. Approximately 139 miles of streams require pollution abatement, through such measures as restriction of livestock use directly in streams and drainages, provision for sanitary facilities for recreation use near waterways and lakes, and maintenance of tree shade and cover to prevent high water temperature and resulting damage to fish life.

Between 1966 and 2020, 7,700 ponds and small reservoirs should be developed with a storage capacity of 78,000 acre-feet. Other necessary water control structures include an estimated 4,000 check dams, 77 water diversions, 22 miles of dikes, and a small number of detention reservoirs.

Check dams help retard excessive runoff and silt deposits, by channel stabilization. Other measures are needed to reestablish desirable plant cover on the watershed. (Bureau of Land Management)

Erosion and Sediment Yield Improvement

Reduction or redistribution of grazing use on some areas and improved vegetative cover should result in a 16 percent reduction of the annual sediment yield, from 819 acre-feet in 1966 to 685 acre-feet in 2020 (table 540). Some areas currently having low sediment yield are protected by non-usable, low production vegetation. Vegetation composition in these areas will gradually be shifted to species providing both range forage and watershed protection.

Table 540 - Annual Sediment Yield Projections from Rangeland, Subregion 12

Sediment Yield 1/ Categories	1966	1980	2000	2020
		Rangeland Acreage (1,000 Acres)		
Very Low	8,733.1	8,726.0	8,741.0	8,767.0
Low	--	--	--	--
Medium	--	--	--	--
High	--	--	--	--
Very High	--	--	--	--
Total	8,733.1	8,726.0	8,741.0	8,767.0
Percent change from 1966	.0	-.1	+.1	+.4
		Annual Sediment Yield (Acre-Feet)		
Very Low	819	773	728	685
Low	--	--	--	--
Medium	--	--	--	--
High	--	--	--	--
Very High	--	--	--	--
Total	819	773	728	685
Percent change from 1966	.0	-6	-11	-16

1/ Very Low through Very High categories represent generalized range areas on which annual sediment yield per square mile averages .06, .15, .35, 1.00, and 2.75 acre-feet respectively. In this subregion all acreage falls in the "Very Low" sediment yield category. Sediment yield is anticipated to decline from .06 acre-feet per square mile annually in 1966 to .05 acre-feet by 2020.

Improved Range Condition and Capacity

Estimated future range improvement, shown on table 541, will result partly from accomplishment of practices for watershed rehabilitation and protection, shown in tables 537, 538, and 539, and partly from other management practices for improved productive capacity of the range. In 1966, only 21 percent of the rangeland was in good range condition. With scheduled improvements, good condition range will be increased to 62 percent by 2020, or from

Table 541 - Estimated Potential Rangeland Improvement - Subregion 12

Range Type and Condition	1966 Acres (1,000)	1966 AUM's (1,000)	1980 Acres (1,000)	1980 AUM's (1,000)	2000 Acres (1,000)	2000 AUM's (1,000)	2020 Acres (1,000)	2020 AUM's (1,000)
Grassland								
Good	320.5	118.2	358.8	132.9	410.2	151.9	491.5	182.0
Fair	193.3	40.5	169.0	35.2	159.8	33.5	100.6	21.0
Poor	96.6	8.5	82.1	7.5	41.1	3.7	20.0	1.9
Seeded Range	355.0	136.9	579.1	222.7	702.4	270.2	779.0	299.6
Total	966.3	304.7	1,189.0	398.3	1,313.5	459.1	1,391.7	504.5
Sagebrush								
Good	1,118.1	338.9	1,490.9	451.5	2,574.6	780.2	4,023.1	1,219.1
Fair	1,863.9	169.4	2,160.4	196.4	2,873.1	261.2	2,277.6	207.1
Poor	4,473.5	223.7	3,575.0	178.8	1,668.7	83.4	762.4	38.1
Total	7,455.8	732.0	7,226.3	826.7	7,116.4	1,124.8	7,063.1	1,464.3
Other Brush								
Good	62.8	24.2	81.9	31.5	112.2	43.2	144.8	55.7
Fair	127.8	31.9	120.5	30.2	128.6	32.1	121.4	30.4
Poor	120.4	10.0	108.3	9.0	70.5	5.9	46.0	3.8
Total	311.0	66.1	310.7	70.7	311.3	81.2	312.2	89.9
Total								
Good 1/	1,857.6	618.7	2,509.8	838.6	3,799.4	1,245.5	5,438.4	1,756.4
Fair	2,185.0	241.6	2,449.9	261.8	3,161.3	326.6	2,499.6	258.5
Poor	4,090.5	242.5	3,766.3	195.3	1,780.3	93.0	829.0	43.8
Grand Total	8,733.1	1,102.8	8,726.0	1,295.7	8,741.0	1,665.1	8,767.0	2,058.7
Average AC/AUM	7.9		6.7		5.2		4.3	
Percent Change from 1966	.0	.0	-.1	+17.5	+.1	+51.0	+.4	+86.7

1/ Includes seeded range.
Source: Table 514 "Present Status" rangeland narrative. Future estimates for this study are based on representative on-site surveys for production guides with consideration to the capability of the range for improvement with proper management and utilization.

1.9 million acres to 5.4 million acres. Poor condition land which accounted for 54 percent of the total range in 1966 will be reduced to only 9 percent by 2020, dropping from 4.7 million acres to 829,000 acres. Major rehabilitation efforts will be directed to this segment of the range. The 1966 grazing capacity of 1.1 million animal unit months is expected to increase to 2.1 million animal unit months in 2020, an increase of 87 percent.

Even with this significant improvement in range condition and grazing capacity, range forage production will meet only about 35.4 percent of the anticipated demand for livestock production in Subregion 12 by 2020 compared to 36.5 percent in 1966.

Estimated Program Costs

Broad investment cost estimates (based on 1969 dollars) are shown in table 542 for the practices shown on tables 537, 538, and 539. Cover improvement and soil stabilization programs will require \$6.3 million between 1966 and 2020, or 35 percent of the rangeland watershed program costs of \$18.1 million. Watershed oriented land management practices require \$3.3 million or 18 percent of total costs, and water control structures require \$8.5 million or 47 percent of the total. Based on the present ratio

of rangeland ownership, an estimated $14.2 million (78 percent of total requirements) will be directed to publicly owned rangeland, while $3.9 million or 22 percent will be required for the private range.

Table 542 - Estimated Cost of Required Measures and Practices for Watershed Protection and Rehabilitation of Rangeland by Major Types of Watershed Programs - Subregion 12 1/

Major Types of Watershed Programs	1966 to 1980 ($1000)	1980 to 2000 ($1000)	2000 to 2020 ($1000)	Total ($1000)
		Public Land		
Cover Improvement and Soil Stabilization	1,445.9	1,684.8	1,840.5	4,971.2
Watershed Oriented Land Management Practices	933.0	938.7	673.0	2,544.7
Water Control Structures	2,034.5	2,248.7	2,347.8	6,631.0
Total	4,413.4	4,872.2	4,861.3	14,146.9
		Private Land		
Cover Improvement and Soil Stabilization	391.5	456.9	503.3	1,351.7
Watershed Oriented Land Management Practices	238.3	276.9	190.0	705.2
Water Control Structures	564.1	641.0	667.9	1,873.0
Total	1,193.9	1,374.8	1,361.2	3,929.9
		Total		
Cover Improvement and Soil Stabilization	1,837.4	2,141.7	2,343.8	6,322.9
Watershed Oriented Land Management Practices	1,171.3	1,215.6	863.0	3,249.9
Water Control Structures	2,598.6	2,889.7	3,015.7	8,504.0
Total	5,607.3	6,247.0	6,222.5	18,076.8

1/ Based on measures and practices shown on tables 537, 538, and 539, with constant 1969 dollars.

Other Land

Other land will increase by over 30,000 acres by the year 2020 in order to meet needs. The increase will be for home and industrial sites, roads, recreation areas, and water. The area of barren lands is expected to remain about the same.

The largest shift in land use is expected to be from cropland, forest land, and rangeland to both large and small water. Irrigation will create the largest change, with over 341,000 additional acre-feet of diversion from reservoir storage. Most of the shift, total area wise, will be to large water. However, about 30 smaller irrigation reservoirs with a combined surface area of almost 1000 acres will be within the other land classification.

In addition to the irrigation reservoirs, about 7,400 small ponds are needed by 2020 to provide water for livestock, wildlife, recreation, fishing, erosion control, and water conservation. These ponds are expected to have a combined storage capacity of about 70,000 acre-feet and surface areas totaling almost 7,000 acres. Over 1800 of the ponds will be needed for erosion control, 700 for local flood prevention, and less than 100 for fishponds. The remainder will include livestock and wildlife water for adjacent cropland, forest land, and rangeland areas.

The area in roads is expected to increase by about 50 percent as more and better roads are constructed. Sediment yield from highways is not expected to increase appreciably even though cut areas are becoming larger, which increase erosion potential. The Oregon State Highway Department has an excellant program for cut and embankment seeding. However, county, logging, and other roads will need a considerable acceleration in the rate of application of erosion control practices.

Urban areas, including industrial sites, etc., are expected to nearly double by 2020. There are measures urban areas can adopt in order to prevent flooding. These would include diking and channel enlargement. New urban developments can be zoned away from floodplains. Waters causing flooding in urban areas originate on adjacent lands. Therefore, reductions in flood flows should start on the adjacent lands.

Sediments causing damage to urban areas and roads, and silt reducing reservoir and pond capacity also originate on adjacent cropland, forest land, and rangeland. Treatment of these adjacent lands is very important to the protection of other land from sediments.

GLOSSARY

AVAILABLE WATER HOLDING CAPACITY - The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

BASIN - A geographic area drained by a single major stream.

BOTTOM LAND - Low land formed by alluvial deposits along a river or stream.

COLUMBIA-NORTH PACIFIC REGION - The geographic area including all of the Columbia River Basin in the United States, the closed basin portion of Oregon, and all of the coastal streams of Oregon and Washington.

CONSTRUCTION COST - The total cost of construction, including real estate, engineering, design, administration and supervision.

CONSUMPTIVE USE - The quantity of water discharged to the atmosphere or incorporated in the products in the process of vegetative growth, food processing, industrial processes, or other use.

CROPLAND - Land regularly used for production of crops and pasture, except forest land, rangeland, and other land.

CROPLAND, IDLE - This includes the land classified as cropland because of prior use but not currently cropped.

CROPLAND, IRRIGATED - Land to which water is usually applied by controlled artificial means. This does not include farm roads, irrigation ditches, or farmsteads.

DIVERSION - The taking of water from a stream or other body of water into a canal, pipe, or other conduit.

DRAINAGE AREA - The drainage area of a stream, measured in a horizontal plane, which is enclosed by a drainage divide.

EROSION, BANK - Destruction of land areas from active cutting of streambanks.

EROSION, BEACH - The retrogression of the shore line of large lakes and coastal waters caused by wave action, shore currents, or natural causes other than subsidence.

EROSION, GULLY - The widening, deepening, and headcutting of small channels and waterways due to erosion.

EROSION, RILL - Removal of soil by running water with formation of shallow channels that can be smoothed out completely by normal cultivation.

EROSION, SHEET - The removal of a fairly uniform layer of soil or materials from the land surface by the action of rainfall and runoff water.

FARM - A place operated as a unit of ten or more acres from which the sale of agricultural products totaled $50 or more annually, or a place operated as a unit of less than ten acres from which the sale of agricultural products totaled $250 or more annually during the previous year.

FEDERAL LANDS - All classes of land owned by the Federal Government, which includes both public domain land and acquired Federal land.

FEDERAL LANDS, WITHDRAWN - Federal lands for which formal withdrawal action has been taken which restricts the disposition of specific public lands and which holds them for specific public purposes; also, public lands which have been dedicated to public purposes.

FLOOD - Any relatively high streamflow or an overflow or inundation that comes from a river or other body of water and causes or threatens damage.

FLOOD PEAK - The highest value of the stage or discharge attained by a flood; thus, peak stage or peak discharge. Flood crest has nearly the same meaning, but since it connotes the top of the flood wave, it is properly used only in referring to stage.

FLOOD PLAIN - A strip of relatively smooth land bordering a stream that has been or is subject to flooding. It is called a "living" flood plain if it is overflowed in times of high water, but a "fossil" flood plain if it is beyond the reach of the highest flood.

FOREST LAND - Land which is at least 10 percent stocked by forest trees of any size and land from which the trees have been removed to less than 10 percent stocking, but which has not been developed for other use.

FOREST LAND, COMMERCIAL - Forest land which is producing, or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation.

FOREST LAND, NONCOMMERCIAL - Unproductive forest land incapable of yielding crops of industrial wood because of adverse site conditions, and productive forest land withdrawn from commercial timber use through statute or administrative regulation.

FOREST LAND, NONSTOCKED - Commercial forest land less than 10 percent stocked with growing stock trees.

FOREST LAND, PRODUCTIVE - RESERVED - Public forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualified as commercial forest land. Examples include the National Parks and National Forest Primitive and Wilderness areas.

FOREST LAND TYPES - A classification of forest land based upon the predominant species in the present tree cover. Types are determined on the basis of majority of stocking by all live trees of various species, considering both size and spacing.

FOREST LAND, UNPRODUCTIVE - Forest land incapable of yielding crops of industrial wood products (usually saw timber) because of adverse site conditions.

FOREST RANGE - Forest land available for the grazing of domestic livestock and wildlife. It may be either commercial or noncommercial forest land.

GROUND WATER - Water in the ground that is in the zone of saturation from which wells, springs and ground water runoff are supplied.

IRRIGATED AREA - The gross area upon which water is artifically applied. This includes farm roads, irrigation ditches, and farmsteads.

IRRIGATION EFFICIENCY - The percentage of water applied that can be accounted for in soil moisture increase.

IRRIGATION REQUIREMENT, CROP - The amount of irrigation water in acre-feet per acre required by the crop; it is the difference between crop consumptive use requirement and effective precipitation.

LAND AREA - The solid portion of the earth's surface including bodies of water less than 40 acres and streams of less than 1/8 mile wide.

LAND CAPABILITY CLASS - A group of capability subclasses and units that have the same relative degree of hazards or limitations. The risks of soil damage or limitation in use become progressively greater from Class I to Class VIII.

LAND RESOURCE - An area of land containing or supporting all or some of certain resources in some combination. The resources include soil, water, timber, forage, wildlife, and minerals.

LAND TREATMENT MEASURES - The application of vegetative measures, tillage practices, and structural installations, individually or in selected combinations, according to land needs and use, to control run-off, prevent erosion, increase fertility and improve the soil.

LAND USE - Primary occupier of a tract of land grouped into classes with similar characteristics, i.e., cropland, rangeland, forest land, or other.

MUNICIPAL WATER - The municipal category includes not only urban domestic water use but also those other civic, commercial, and small industrial uses which are typically supplied through a municipal distribution system and the magnitude of which is related to local population.

NEED - The quantity of a service, commodity, or resource required to satisfy a projected essential requirement and objective, a goal, or even a desire.

NONSTRUCTURAL MEASURES - Measures for managing, utilizing, or controlling water and related lands without structural development to achieve the desired objective. Such measures include flood plain zoning, flood warning systems, legal restraints, and preservation, as well as the more common land management measures.

OPERATION AND MAINTENANCE COSTS - Average annual costs of project operation and normal maintenance.

OTHER LAND - All land not classified as cropland, rangeland, or forest land is included in this group. Other land includes barren and industrial urban areas, farmsteads, roads, railroads, airports, water surfaces under 40 acres in size or less than 1/8 mile wide, etc.

PERCHED WATER - Ground water separated from the underlying water table by a zone of impervious or relative impervious material.

PERCOLATION - The movement, under hydrostatic pressure, of water through the interstices of a rock or soil.

PERMEABILITY - The quality of a soil that enables water or air to move through it.

POLLUTION - Pollution is the alteration of the physical, chemical, or biological properties of water, or a discharge of any substance into water, which adversely affects any legitimate beneficial water use.

PRECIPITATION - As used in hydrology, precipitation is the discharge of water, in liquid or solid state, out of the atmosphere, generally upon a land or water surface. It is the common process by which atmospheric water becomes surface or subsurface water. The term "precipitation" is also commonly used to designate the quantity of water that is precipitated.

PROJECT - Any separable physical unit or closely related units, existing, undertaken, or to be undertaken within a specific area for control and development of water and related land resources, which can be established and utilized independently or as an addition to an existing project, and can be, or has been, considered as a separate entity for purposes of evaluation.

PUBLIC DOMAIN LANDS - Original public domain lands which have never left Federal ownership; also includes lands in Federal ownership which were obtained by the Federal Government in exchange for public lands, or for timber on public lands.

RAINFALL - The quantity of water that falls as rain. Not synonymous with precipitation.

RANGELAND - Land in grass or other long-term forage growth of native species used primarily for grazing. It may contain shade trees or scattered timber trees with less than 10 percent canopy. It includes grassland, land in perennial forbs, sagebrush land, and brushland other than sage.

RANGELAND CONDITION CLASS - Range condition estimates are based on a numerical index, rating the forage stand and the site and soil mantle. The numerical ratings have been combined for a comprehensive classification of range condition common to range managing agencies in the following relative terms: Excellent, Good, Fair, Poor, and Bad. In this study the Excellent and Good classifications have been combined as have Poor and Bad categories, and range conditions are discussed in terms of Good, Fair and Poor.

RANGELAND CAPACITY (GRAZING CAPACITY) - This is the maximum stocking rate of the range possible without inducing damage to vegetation and related resources or without preventing rehabilitation of previous damage by overgrazing. Capacity is discussed in terms of animal unit months or acres per animal unit month.

Animal Unit - A measure of livestock numbers by which kinds, classes, and ages are converted to an approximate common standard in relation to feed and forage resources based on the equivalent of a mature cow (approximately 1,000 lbs. live weight). In western range territory, an animal unit is roughly one head of cattle, one horse, one mule, five sheep, five swine, or five goats - a suitable average of the generally lower ratio between these kinds of livestock on the range and the higher ratio in the feed lot.

Animal Unit Month - A measure of forage or feed requirement to maintain one animal unit for a period of 30 days. Abbr. AUM.

RECHARGE (GROUND WATER) - The addition of water to the zone of saturation. Infiltration of precipitation and its movement to the water table is one form of natural recharge; injection of water into an aquifer through wells is one form of artificial recharge.

RESERVOIR - A pond, lake or basin, either natural or artificial, for the storage, regulation, and control of water.

RESERVOIR, RETARDING - Ungated reservoir for temporary storage of floodwater. Sometimes called a detention reservoir.

RUNOFF - That part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage or other works of man in or on the stream channels.

RURAL-DOMESTIC WATER - The rural domestic category includes water uses for domestic needs, stock watering, small scale irrigation, etc., of individual homes, farms or ranches, and rural centers with a population of less than about 250 people.

RURAL POPULATION - All population not classed as urban and is divided into rural farm and rural nonfarm population.

Rural Farm Population - All residents living on farms of less than ten acres yielding production which sold at $250 or more in the previous year, or of ten acres or more with production sold at $50 or more in the previous year.

Rural Nonfarm Population - All rural population not classed as farm. This includes residents of unincorporated settlements, hamlets and villages and incorporated cities, boroughs, villages, and towns, both categories having less than 2,500 population.

SALINE SOIL - A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

SEDIMENT - Fragmental or clastic mineral particles derived from soil, alluvial, and rock materials by processes of erosion; and transported by water, wind, ice, and gravity. A special kind of sediment is generated by precipitation of solids from solution (i.e., calcium carbonate, iron oxides). Excluded from the definition is vegetation, wood, bacterial and algal slimes, extraneous light-weight artificially-made substances such as trash, plastics, flue ash, dyes, and semi-solids.

SEDIMENT DISCHARGE - The rate at which dry weight of sediment passes a section of a stream or the quantity of sediment, as measured by dry weight or by volume, that is discharged in a given time.

SILT - Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeters) to the lower limit of very fine sand (0.05 millimeters). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

SOIL DEPTH - The depth of soil material that plant roots can penetrate readily to obtain water and nutrients. It is the depth to a layer that, in physical or chemical properties, differs from the overlying material to such an extent as to prevent or seriously retard the growth of roots or penetration of water. The depth classes are: (1) very deep, more than 60 inches; (2) deep, 40 to 60 inches; (3) moderately deep, 20 to 40 inches; (4) shallow, 10 to 20 inches; and (5) very shallow, 0 to 10 inches.

SOIL MOISTURE - Water diffused in the soil, the upper part of the zone of aeration from which water is discharged by the transpiration of plants or by soil evaporation.

STORAGE - Water naturally or artificially impounded in surface or underground reservoirs.

STREAM - A general term for a body of flowing water. In hydrology, the term is generally applied to the water flowing in a natural channel as distinct from a canal. More generally, as in the term stream gaging, it is applied to the water flowing in any channel, natural or artificial.

STREAM CLEARANCE - The removal of natural or man-caused debris from stream channel areas by mechanical means.

STREAMFLOW - The discharge that occurs in a natural channel. Although the term discharge can be applied to the flow of a canal, the word streamflow uniquely describes the discharge in a surface stream course. Streamflow is a more general term than runoff, as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.

STREAMFLOW REGULATION - The artificial manipulation of the flow of a stream.

SUBBASIN - A portion of a subregion or basin drained by a single stream or group of minor streams.

SUBREGION - The subdivisions of a region defined along drainage basin boundaries for study and report purposes. The Columbia-North Pacific Region's subregions are:

1. Clark Fork-Kootenai-Spokane
2. Upper Columbia
3. Yakima
4. Upper Snake
5. Central Snake
6. Lower Snake
7. Mid Columbia
8. Lower Columbia
9. Willamette
10. Coastal
11. Puget Sound
12. Oregon Closed Basin

SUPPLEMENTAL IRRIGATION - When irrigation water supplies are obtained from more than one source, the source furnishing the initial supply is commonly designated the primary source, and the sources furnishing the additional supplies the supplemental sources.

UPLAND (GEOLOGY) - The land consisting of material unworked by water in recent geologic time and generally at a higher elevation than the alluvial plain or stream terrace; land above the lowlands along rivers or between hills.

URBAN POPULATION - All persons living in (a) places of 2,500 inhabitants or more incorporated as cities, boroughs, villages and towns (except towns in New England, New York, and Wisconsin); and (b) the densely settled urban fringe, whether incorporated or unincorporated, or urbanized areas.

WATER AREA - Water areas of more than 40 acres and water courses more than 1/8 mile wide.

WATERSHED - A term to signify drainage basin or catchment area.

WATERSHED PROTECTION - The treatment of watershed lands in accordance with such predetermined objectives as the control of erosion, stream flow, silting floods, and water, forage, or timber yield.

WATER SPREADING - Diverting run-off from natural channels or gullies by means of a system of dams, dikes, or ditches, and spreading it over relatively flat areas.

WATER YIELD - Runoff, including ground water outflow that appears in the stream, plus ground water outflow that leaves the basin underground. Water yield is the precipitation minus the evapotranspiration.

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COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
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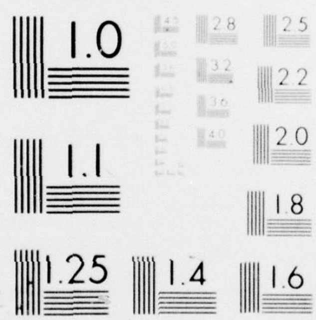

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PARTICIPATING STATES AND AGENCIES

STATES

Idaho
Montana
Nevada
Oregon
Utah
Washington
Wyoming

FEDERAL AGENCIES

Department of Agriculture
  Economic Research Service
  Forest Service
  Soil Conservation Service
Department of the Army
  Corps of Engineers
Department of Commerce
  Economic Development Adm.
  National Oceanic & Atmospheric Administration
    National Weather Service
    National Marine Fisheries Service
Department of Health, Education, & Welfare
  Public Health Service
Department of Housing & Urban Development
Department of Transportation
Department of the Interior
  Bonneville Power Adm.
  Bureau of Indian Affairs
  Bureau of Land Management
  Bureau of Mines
  Bureau of Outdoor Recreation
  Bureau of Reclamation
  Fish and Wildlife Service
  Geological Survey
  National Park Service
Department of Labor
Environmental Protection Agency
Federal Power Commission